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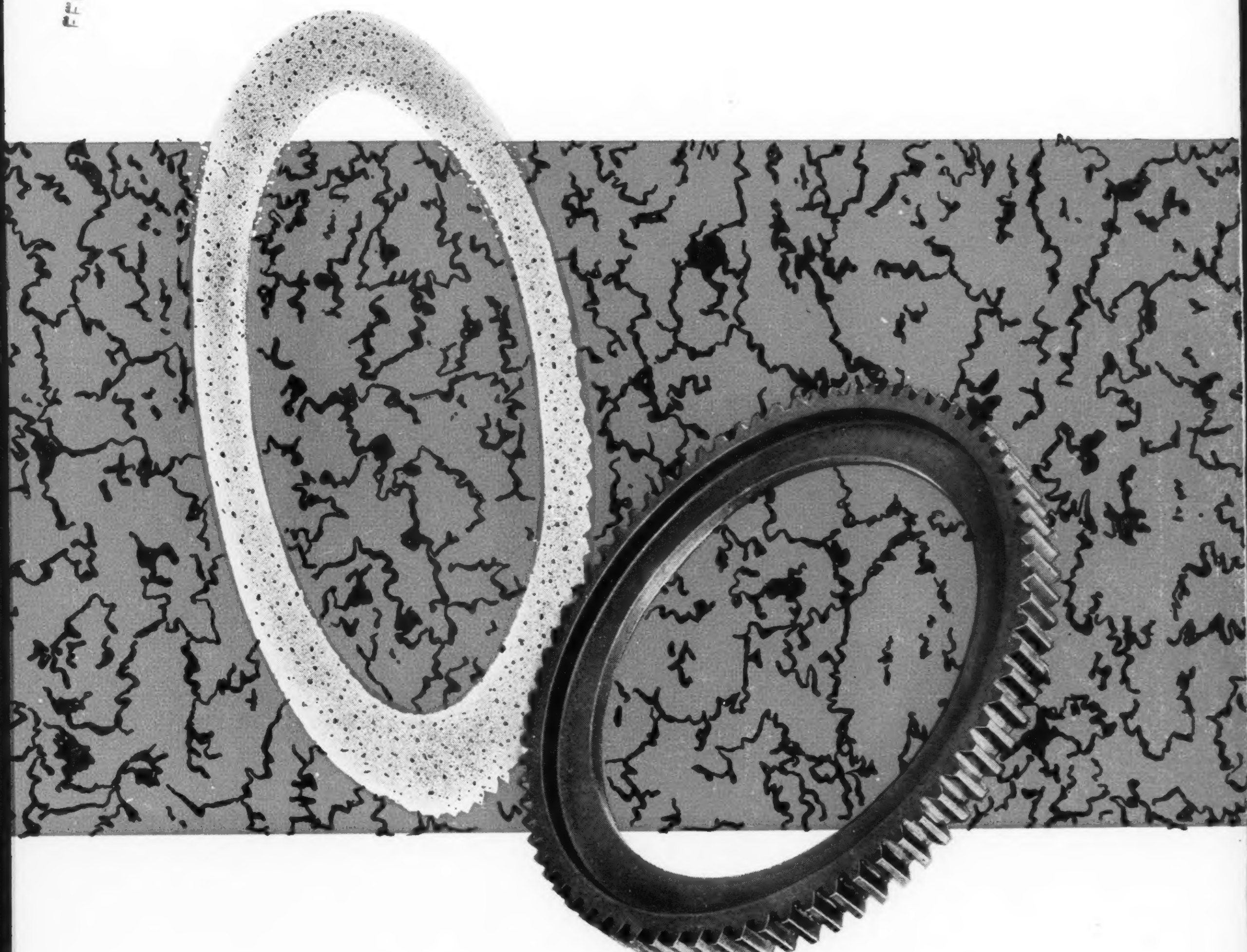


METAL PRODUCTS FROM POWDER, PRESSURE, HEAT (Page 27)

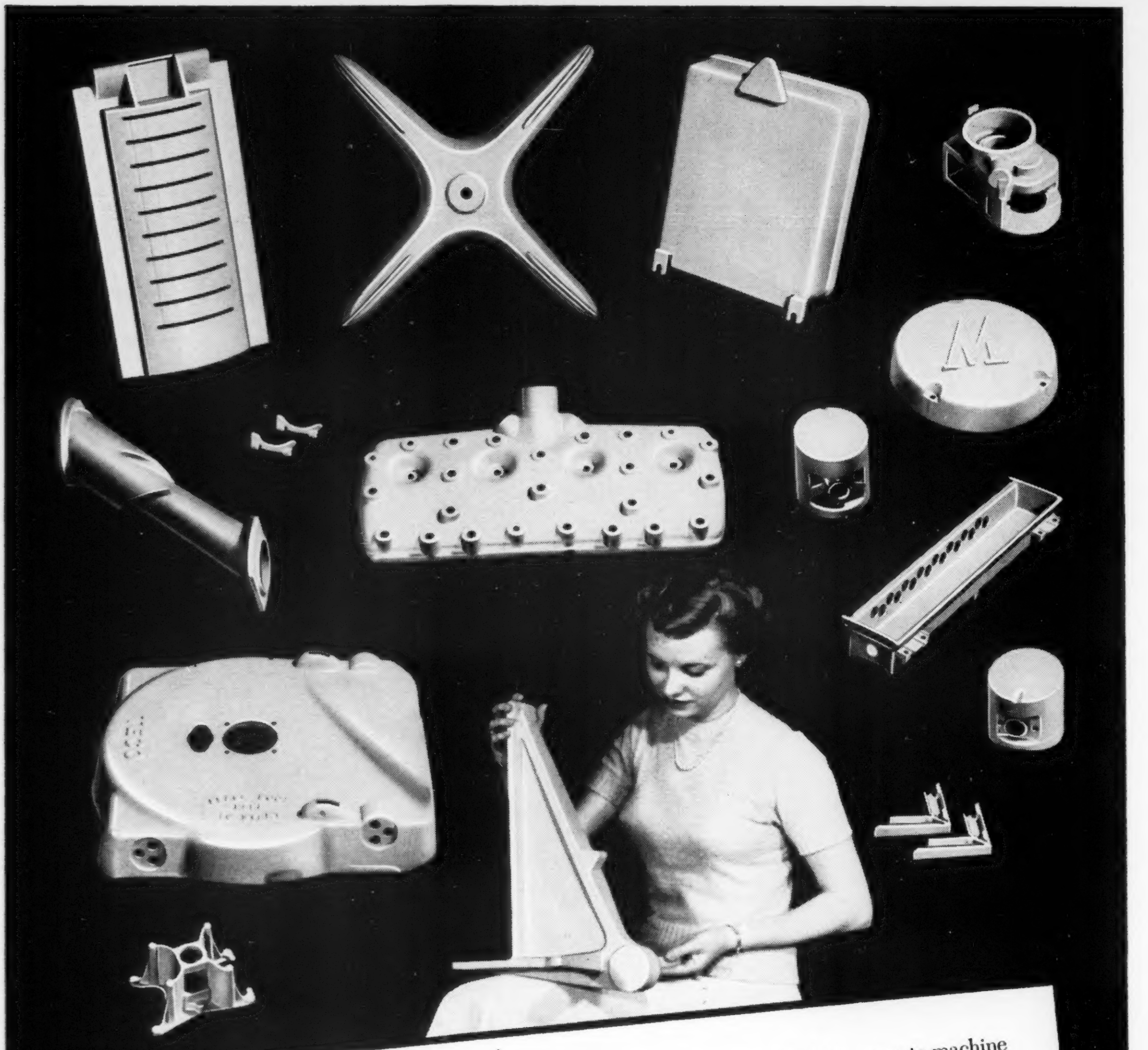
Ancient Egyptian metallurgy goes modern

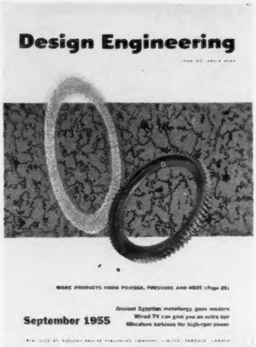
Wired TV can give you an extra eye

Miniature turbines for high-rpm power

September 1955

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA





Design Engineering

VOLUME 1 **SEPTEMBER, 1955** NUMBER 6

This month's cover

How could the story of powder metallurgy be told on the cover for September? The editors felt such a complex subject must be subtly treated. Artist Harry Howard finalized with this arresting layout. The metal powder to the left is shown on an actual enlargement of powder under compression before it is heated. The finished product rests on the right. In three steps the ancient art of powdered metallurgy and the sintering process are vividly depicted.

Design Engineering

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This highly skilled crew aboard Avro Aircraft's powerful CF-100 Mark 4 will soon be racing with sound up under the rim of the stratosphere.

In RCAF operational multi-squadron service in Canada, squadrons of CF-100s will begin duty with NATO forces in Europe by 1956.

Inside

William Morse B.Sc., P.Eng.
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MANAGING EDITOR
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ASSISTANT EDITOR
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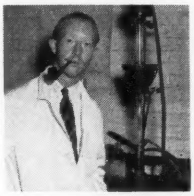
Editorial correspondents in: The United Kingdom, the United States, Germany, France and Italy.

The September issue of **Design Engineering** will carry strong feature articles written by contributors no less experienced than those featured this month.

Vacuum metallizing, our cover feature for October, deals with the method of applying metallic finishes to different materials.

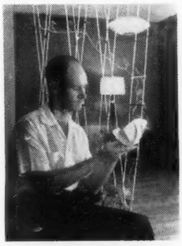
Subminiature electronic tubes offer design engineers countless possibilities for use in design where space is limited. Their story is fully covered in next month's issue.

Special Artwork
Editorial layouts designed by art consultant **Desmond English.**



Last

AN ORIGINAL desire to become a chemical engineer was slanted to a shorter course when Anthony Last, contributor of the colorful story on powdered metallurgy (page 27), came out of the RAF. He wanted to get into active research as soon as possible rather than spend long years of study, so he enrolled in London University School of Mines. Coming to Canada in 1951 he shortly joined the Ontario Research Foundation. Editor of a rugger magazine, he also likes to drive sports cars.



McIntosh

A CLASH between the strict discipline of applied science and industrial design in production (page 55) really floored the writer, Laurie McIntosh, when he followed his Mechanical Engineering degree from Toronto University with a course at the Institute of Design in Chicago. He was psychologically shocked, he says, at the routine of cutting paper and bending wire. But later in the year he realized the value of basic training in abstract design. On the staff of Massey-Harris since 1951 as an industrial design engineer, he also maintains a private practice.

Walter

A NEW LIGHT is thrown on television in Leo Walter's story about industrial TV in the U. K. (page 34). An independent technical consultant and author, he is a graduate of the Technical University of Vienna, Austria. Postgraduate studies in industrial instruments, followed by several years in industry, preceded establishment of his own business. The 1938 Nazi invasion prompted him to come to England where he organized plans which led to his independence.

Davy

DURING WAR years while he trained for a pilot in Saskatchewan, aeronautical engineer Michael Davy, who wrote the story on stress lofting (page 40) made up his mind to return. His engineering education, interrupted from 1942-46, he finished, and with a B.Sc. from London University left for Canada in a short time. When he is not working on aircraft design at de Havilland of Canada he is making model planes and pottering in his workshop.

Reports

News in brief from the world's producers

OSHAWA—Two Canso amphibian aircraft, property of the **Photographic Survey Corporation Ltd.,** will leave here late this fall bound for the Antarctic.

Both aircraft are presently being modified in preparation for their role in the British Government's aerial survey expedition of the Grahamland Peninsula, a dependency of the Falkland Islands.

First aircraft operators to fly from all seven continents, the Canadian company was chosen because of its worldwide experience—a good proportion of it in polar regions.

PSC have flown more than five million miles in exacting survey work. Aerial survey of Pakistan by the company is now nearing completion under the Colombo plan. This project alone covered over 297,000 square miles.

In the Antarctic operation, the airplanes will fly to the British meteorological station at Deception Island, where they will be based on the water with a mother ship from London.

Emergency landings can be made on a flat area of lava on Deception Island if the water surfaces become obstructed by ice.

Bad weather problems are to be further met with a radar ground control aid.

Geophysical exploration will be carried out through present modifications and equipment to be added later and mapping from the air photos will be done by ground survey teams, flown to control points by a helicopter.

Through the four months of the Antarctic summer — November to April — while the survey is taking place, a separate crew will care for aircraft and cameras to maintain the greatest efficiency.

Leader of the expedition is P. G. Mott, technical director of Hunting Aerosurveys Limited of London, England.

Flying operations will be commanded by J. H. Saffery, D.S.O., flying manager of the company.

• • •

LEASIDE—Canada's aircraft industry will be boosted by the decision of **Minneapolis-Honeywell Co. Ltd.,** to establish an Aeronautical Division at its plant here.

Launching of the new division, which will make aircraft control equipment such as gyros, is closely tied in with the industry's broad expansion.

Vice-president and general manager of the company, W. H. Evans, says that apart from more aircraft equipment being made in Canada, there will be a close liaison between the company, Canadian airplane manufacturers and our military services, through expansion of the engineering staff.

"Automatic control is vital to aviation progress, and we are going now to provide the industry with equipment made in Canada," he stressed.

Support for Canadian customers will be available from the Aeronautical Division in Minneapolis, although the Canadian operation is to be independent.

• • •

CHICAGO—The 1959 fifteenth annual conference and exhibition of the **National Association of Corrosion Engineers** will be held here, it has been announced. Sherman Hotel will be headquarters for the technical sessions and exhibition.

The 1956 meeting will be in New York at Hotel Statler; 1957 in St. Louis and 1958 in San Francisco.

• • •

SCARBOROUGH—A modern plant for the handling and processing of nonferrous scrap is being erected in this Toronto suburb by **Federated Metals Ltd.**

Part of an over-all expansion program, the Scarborough plant will be followed by construction of a similar operation in Montreal where the company operates plants on leased property at present.

General manager of Canadian operations, Paul H. Jackson, said the plants are being built because of the growth in business.

Modern nonferrous scrap handling and processing to supply the domestic and export trade, he said, would be supplemented by the company's role as Canadian agent for the American Smelting and Refining Company's continuous cast bronze department. Federated is one of its subsidiaries.

A reverberatory furnace will be operated at the Scarborough plant, while future Montreal plans call for expansion in the plant's lead fabrication facilities. A rolling mill will be set up for producing sheet lead. Lead pipe and wire solder presses, lead trap and bend presses and spinning lathes for fabricated lead products are also planned.

Sufficient acreage had been allowed to allow for future expansion at both locations.

• • •

OAKVILLE — A radiographic company, who began operations in small rented quarters, and 18 months later filled a 4,000-square foot plant, has just completed a new addition to add even further industrial impetus to this thriving lakeshore town.

Canadian Isotope Product's 3,000-sq. ft. addition, designed to incorporate special radiographic facilities, was necessary due to the company's expansion which outgrew the earlier quarters.

The radiographic laboratory is separated from adjacent rooms by a foot-thick reinforced concrete wall. Within a dozen feet of the area a film storage vault will hold film. Built below the ground, the vault takes added advantage of the subsurface soil as an inexpensive radiation shield.

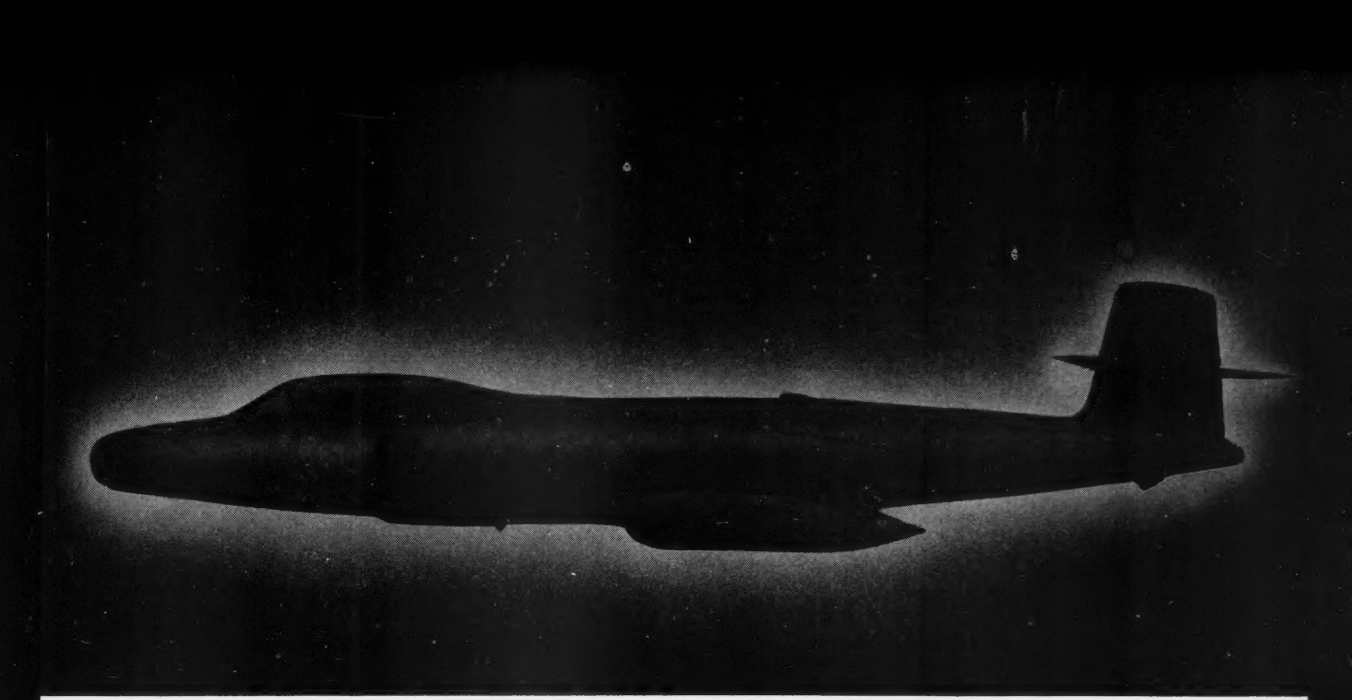
Production and testing of isotope gauging equipment will occupy almost all of the older building, which was erected in 1951.

Sales, purchasing, engineering and general offices, as well as a board room and library will also be located in the new building.

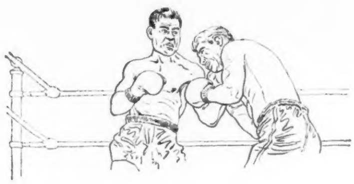
• • •

IT IS REPORTED that Moffats Ltd., have purchased **Alvar Simpson Ltd.,** air conditioning and heating equipment distributors and that they will shortly be making this equipment in Canada.

A new plant for Federated Metals



How a fighter loses weight and gains strength...



A boxer "sweats off" excess poundage when he wants to make the weight. Often this results in loss of strength and sometimes the fight. On the other hand a fighter aircraft can lose weight by using Canada Decal Transfers and not lessen its fighting power one iota.

Aircraft have lost as much as 18 pounds with the use of tough Canada Decalcomania Transfers in place of metal plates for pilot instructions, instrument dial markings, fuselage and engine markings.

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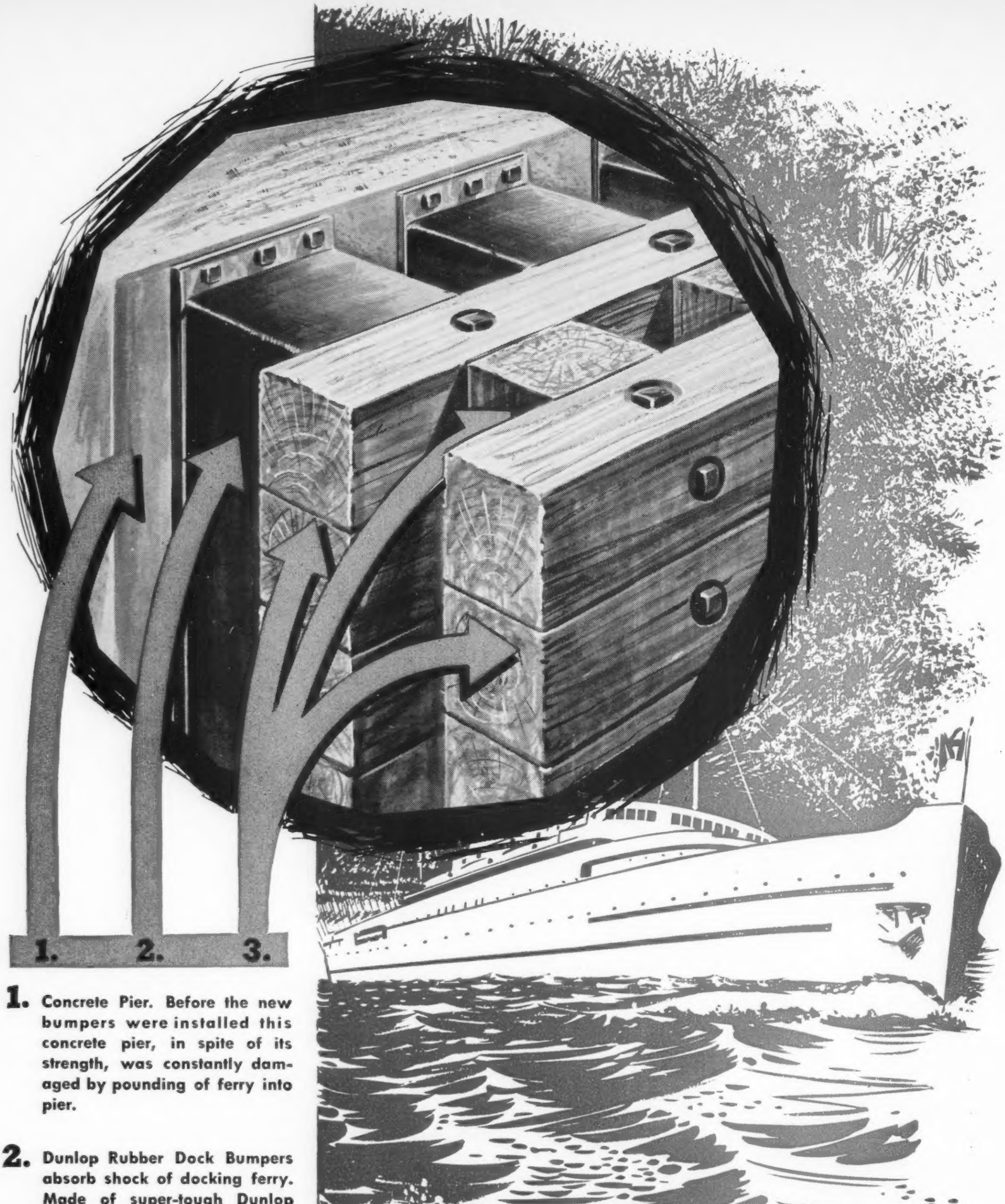
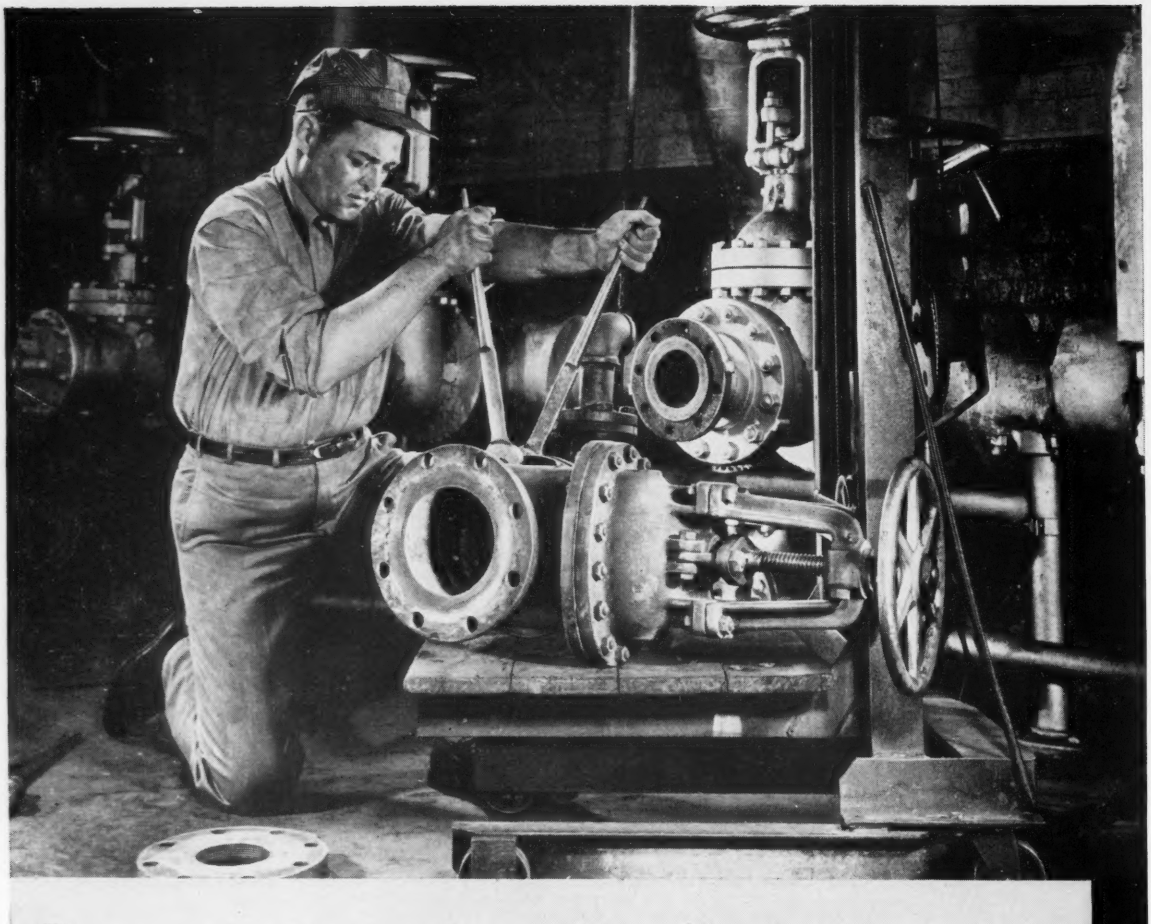


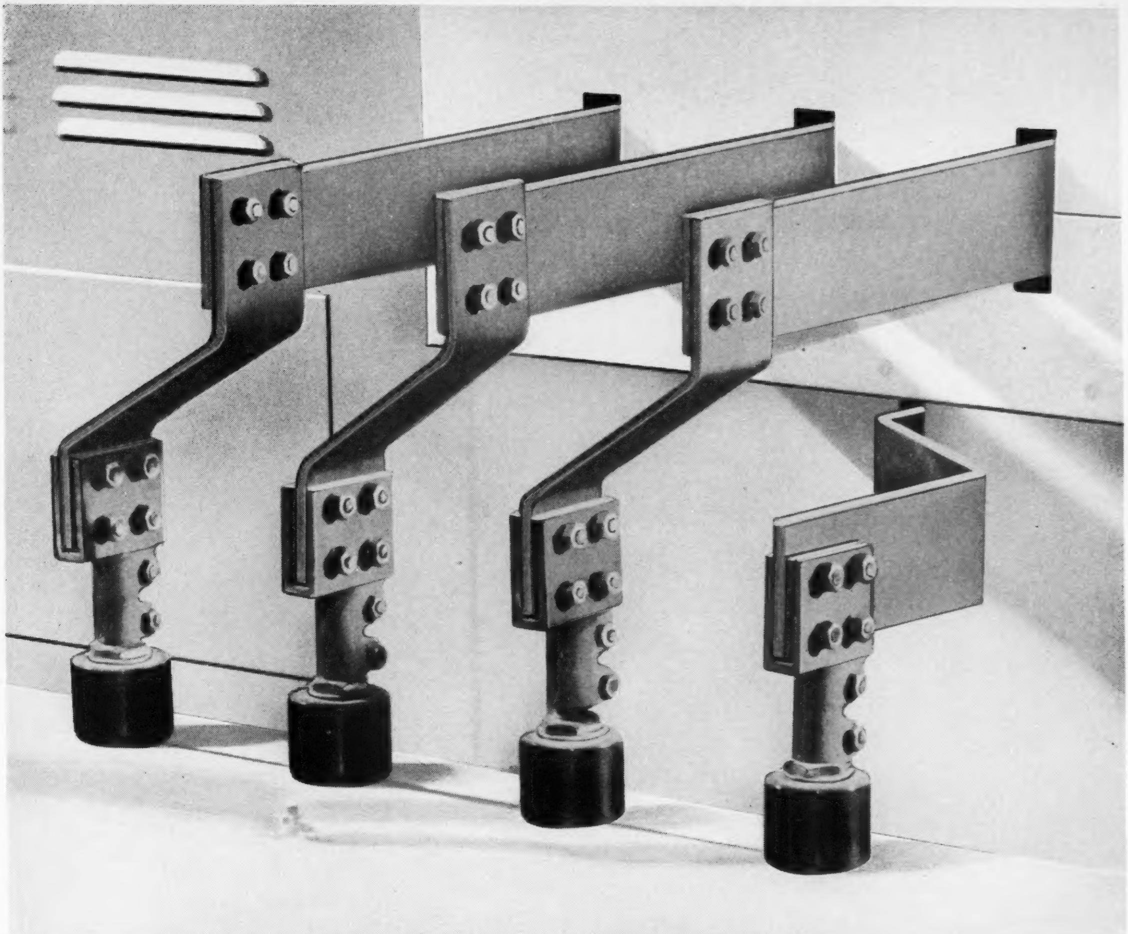
1. Concrete Pier. Before the new bumpers were installed this concrete pier, in spite of its strength, was constantly damaged by pounding of ferry into pier.

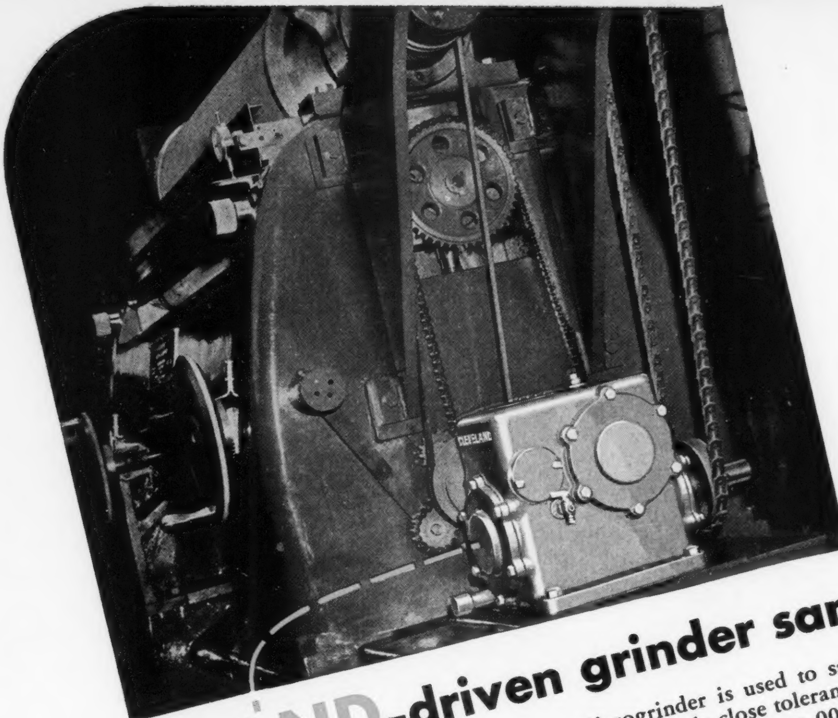
2. Dunlop Rubber Dock Bumpers absorb shock of docking ferry. Made of super-tough Dunlop Rubber they have reduced damage and maintenance to a minimum.

3. Horizontal and vertical timber cribs bolted in place as shown.

Six sections of aluminum ductwork assembled into a 16' length on the floor are easily lifted for erection.







• Cleveland OOD double reduction type speed reducer installed on a Microgrinder. Photo courtesy Curtin-Herbert Co., Inc., Gloversville, N. Y.

CLEVELAND-driven grinder sands to .001″

THIS highly accurate Microgrinder is used to sand wide webbed material to extremely close tolerances. In some production jobs it sands to plus or minus .0005″. Such precision work demands dependable, uniform power transmission—and a Cleveland double reduction worm gear speed reducer has a vital part of the job.

The abrasive-wrapped cylinder is driven by a 20 hp motor. A belt drive runs from the cylinder to the Cleveland speed reducer, and the back-up roll is chain driven from the reducer. The extended intermediate shaft drives a ball bearing eccentric which oscillates the cylinder.

Clevelands fit perfectly into complex power transmission jobs. They're compact—right angle construction of a worm gear drive saves space. High shock load resistance and efficient performance are inherent. Parts are reduced to a minimum, reducing maintenance. Torque flow is smooth and uninterrupted. The case-hardened steel worm and nickel-bronze gear actually improve with use.

Wherever you have a power transmission need or problem, simple or complex, find out how a Cleveland speed reducer can handle it dependably and economically. Send for Catalog 400 today. Peacock Brothers Limited, P. O. Box 1040, Montreal 3, Que. Branch offices in Sydney, Toronto, Sudbury, Winnipeg, Edmonton, Calgary and Vancouver.

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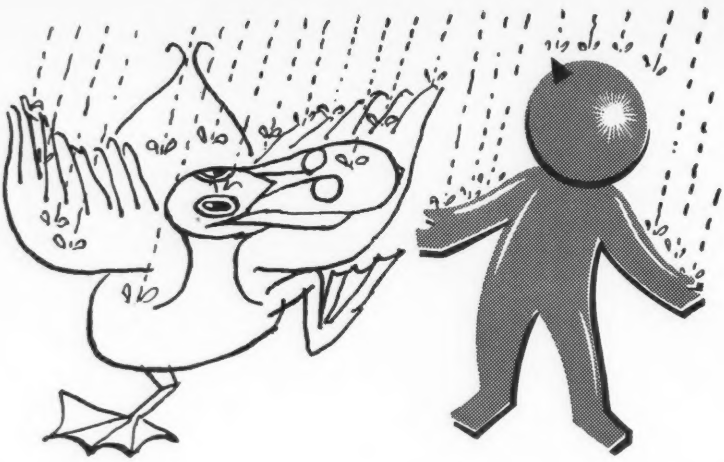

G-E Silicones...learn a lesson from the ducks

G-E Water Repellent Silicones shed water like a duck's back.... Industrial designers find the water repellency properties of Silicones have added greatly to the public acceptance of their products ... have increased sales. Perhaps they will help improve your products, too—increase your profits.

For instance, leather, even suede, treated with G-E Silicones enables shoes to shed water . . . yet the leather can breathe for added comfort.

Silicones will protect your clothes... keep you dry. Applied to gabardines, acetates, broadcloths, flannels, silks, synthetics and blended fabrics, G-E Dri-Film 81432 makes them shower proof . . . and increases their abrasion and tear resistance.

You can also add years of life to masonry with G-E Dri-Film 103. This colourless Silicone liquid, sprayed or painted on stone, cement, brick, stucco or asbestos shingles, will preserve the beauty of industrial and commercial buildings and homes.

And, Silicones even help the deaf to hear better. Hearing aids, coated with G-E Dri-Film 88 help eliminate static troubles caused by moisture. On other delicate electronic equipment, it protects intricate circuits from moisture and corrosive atmospheres.

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Silicone News

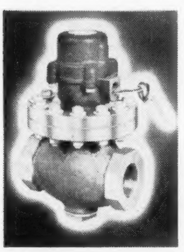
FOR DESIGN ENGINEERS

Silicone Insulation Expands Market for Electric Valves

You can open new markets for electric machines and electronic devices simply by offering units insulated with Dow Corning silicones. That's been the experience of many manufacturers including the Atkomatic Valve Co., Inc., of Indianapolis.

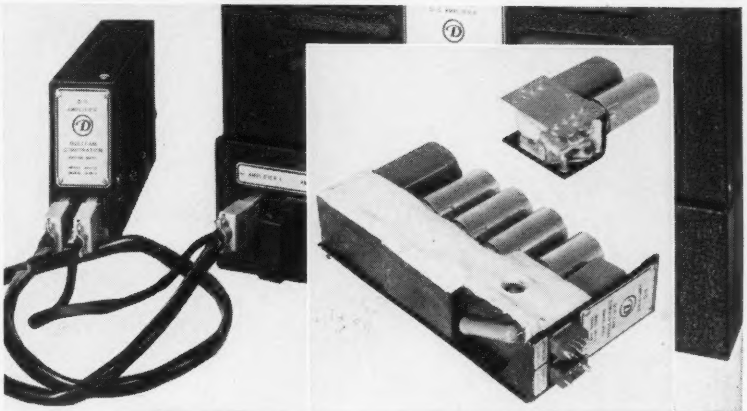
The solenoid operated valves manufactured by Atkomatic have always been popular for use in inaccessible locations because of their fast, hammerless operation and remote controllability. Their application has been somewhat restricted, however, by the operating temperature limits of 180 F imposed by the organic insulating materials in the solenoid coils.

Atkomatic designers removed that temperature limitation and at the same time expanded their markets by developing a special series of solenoid coils insulated with heat-stable silicones. Capable of operating to 450 F, the silicone insulated coils can be used on valves exposed to the most rugged high pressure steam service. They open up an important new market by making it possible to use solenoid operated valves in automatic control systems for general space heating and for production lines handling hot liquids. *No. 48*



Silicone products most widely used, are indexed by type of application, in the 1955 Reference Guide to Dow Corning Silicone Products. A brief but comprehensive 8-page summary is given of the properties and applications. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design, production and maintenance engineers. *No. 49*

Temperature stable pressure sensitive silicone adhesives that stick to almost any material, can be applied and retain useful bond strength at temperatures from —100 to 500 F. Uses include bonding silicone treated electrical insulating materials and as a temporary bond to facilitate assembly of small parts prior to mechanical installation. *No. 50*



Sensitive Amplifier Made Practical With RTV Silastic Used As Potting Compound

Adequate protection of delicate electronic devices requires a potting compound that has a unique combination of properties. Doelcam Division of Minneapolis Honeywell, Boston, found RTV Silastic* to be the only material with all of the essential properties for potting a very sensitive amplifier.

The problem was to design for the National Bureau of Standards a highly sensitive d-c amplifier that would require minimum space; withstand hard service and still amplify signals as low as $6x10^{-4}$ volts to a full scale output of 100 volts.

This amplifier was so delicate that merely breathing on exposed vacuum tube terminals when the amplifier was cold caused intolerable outputs. It was necessary to protect the circuitry against moisture; avoid new leakage paths; provide a cushion to eliminate drift errors in the amplifier output. Conventional potting compounds were not practical because they exerted enough pressure on curing to alter the relative positions of the components and change circuit values.

Success of the new unit, therefore, depended upon finding a potting compound which would flow gently into place; cure at room temperatures; exert negligible pressure on components; and exclude moisture. Good dielectric properties, inertness, resistance to fungus growth and the ability to absorb shock and the expansion and contraction of metals were other requirements.

After testing a wide variety of potting compounds, Doelcam found that RTV Silastic in the fluid consistency was the only material with all of the properties required. Leakage current at 500 volts, for example, registered less than $2x10^{-9}$ amps through a cubic centimeter of cured RTV Silastic. This was below the noise level of the measuring instrument. Even when wires with a 1/32 inch coating of RTV were dipped into salt water, this value remained unchanged. *No. 47*

* T.M. REG. DOW CORNING CORPORATION

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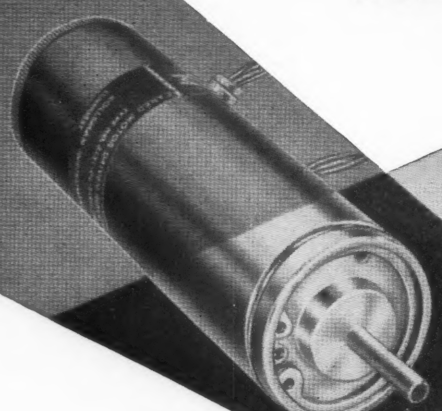

NEW

integral gear head in small servo motors

A new line of units has been added to the Kollsman "Special Purpose Motors" family. It consists of Induction Motors and Induction Generators that are supplied separately or combined in a single case one-inch in diameter. These new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators give maximum output voltage with minimum residual voltage and phase shift.

A particularly interesting feature of Kollsman "Special Purpose Motors" is the interchangeability of parts permitting numerous electrically different combinations of motor and generator windings within the same case.

Principally, Kollsman "Special Purpose Motors" are for operation in 60 or 400 cycle systems. Power output does not exceed 1/100 horsepower. Gear ratios as high as 1:78,000 available.

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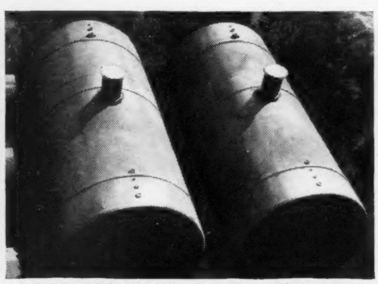

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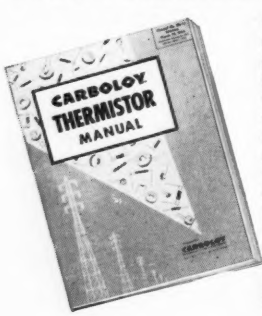
8. **Will reduce cost, size and weight of products and processes.**
9. **They last indefinitely — need no maintenance.**

CARBOLOY THERMISTORS

Free Technical Manual Gives Application Data and "Ideas"



This free technical book, Carboloy Thermistor Manual, gives extensive information helpful to persons concerned with the design or improvement of products and processes. It includes basic circuits and performance curves, and "idea" circuits, with curves, are provided as a guide to the best utilization of the unusual operating and physical characteristics of G-E Carboloy Thermistors. Write for this 56-page manual today. Mail the coupon below.

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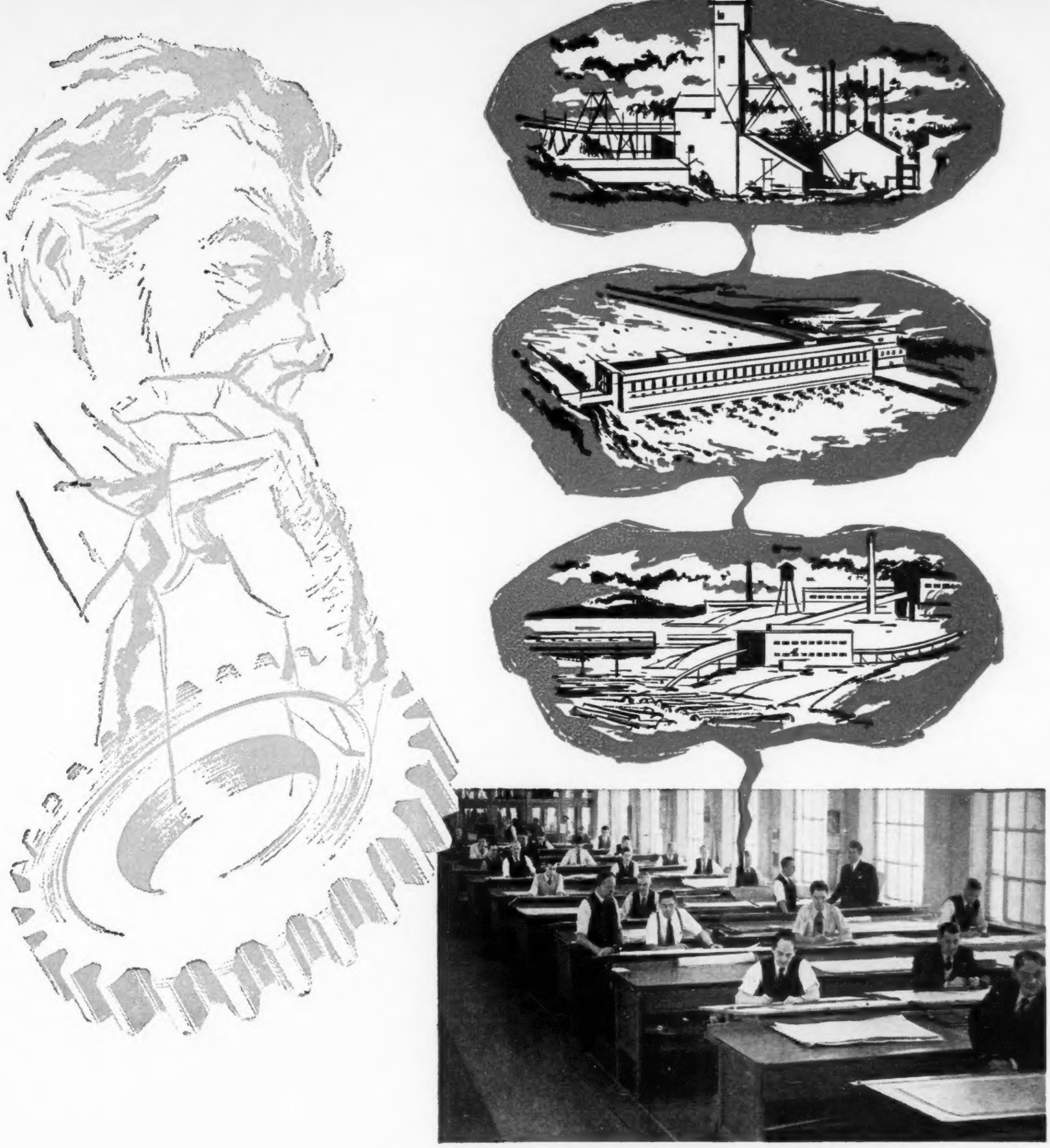
CANADIAN GENERAL ELECTRIC COMPANY LIMITED



One of the 6 drawing offices at Dominion Engineering Works Ltd.

Mechanized thoughts

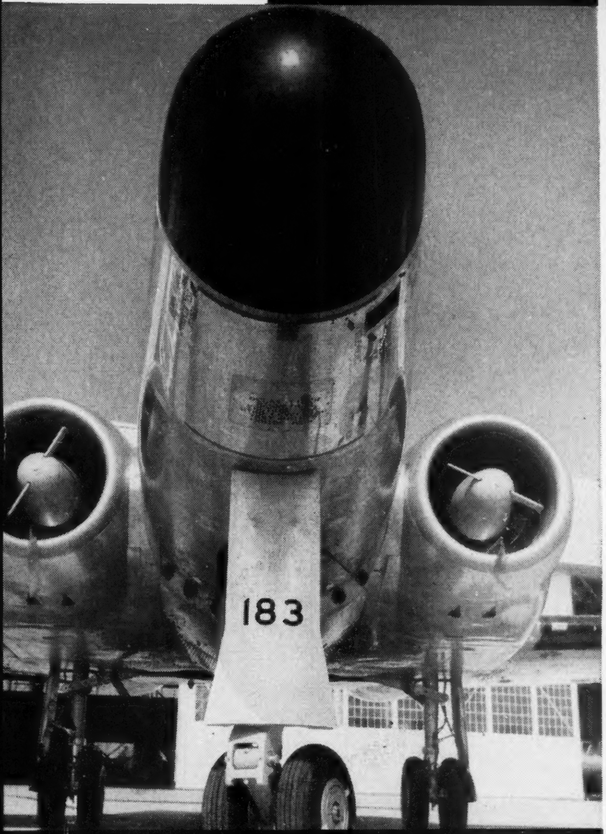
Dominion Engineering salutes the engineers who turn dreams of progress into great practical achievements!

Working with the administrators and planners, Canadian engineers provide the knowledge and experience which make possible massive undertakings and developments. These men, who are second to none in the world, give practical expression to the vast potential of our country. North to South, coast to coast, their enduring monument is an ever greater Canada.

Dominion Engineering Company, Limited
Montreal, P.Q.

CANADIAN INDUSTRY SAVES WITH

NICKEL ALLOY STEELS



AVRO'S CF-100 meets the terrific stresses of landing with landing gear units made from Type 4340 Nickel-Chromium-Molybdenum steel.

HIGH STRENGTH PERMITS WEIGHT REDUCTIONS

Savings with Nickel Alloy Steels begin with the important weight reductions due to inherent high strength characteristics. Thin, light sections of these economical steels provide the same strength as thicker, heavier sections of plain carbon steels. Where space and weight limitations are of importance, as in landing gear units of aircraft, this feature of Nickel Alloy Steels becomes a safety "must".

EASILY FORMED AND WELDED

Nickel Alloy Steels often contribute to lower unit-labour costs due to their excellent performance response to usual fabrication methods. They are easily formed and welded, features which are especially suited for fabricating heavy-duty equipment requiring maximum ruggedness and stamina with minimum weight.

RESISTANT TO CORROSION, ABRASION AND IMPACT

Lower maintenance and replacement costs complete the savings picture with Nickel Alloy Steels. Their high resistance to conditions of corrosion, abrasion and impact mean longer service life . . . more profitable operation.

Nickel Alloy Steels are available from Canadian steel mills in a wide range of varieties to meet specific applications.

Snowmobiles serving in Arctic cold keep vital parts strong, light and free of embrittlement failure with Nickel Alloy Steels.

Nickel Alloy Steels contribute to economical operation of refineries where resistance to corrosion and abrasion play an important part.

Light weight and high strength are vitally important in the construction of mine cars and skips, trucks and highway bus bodies.

EMBLEM OF INCO SERVICE
TRADE MARK

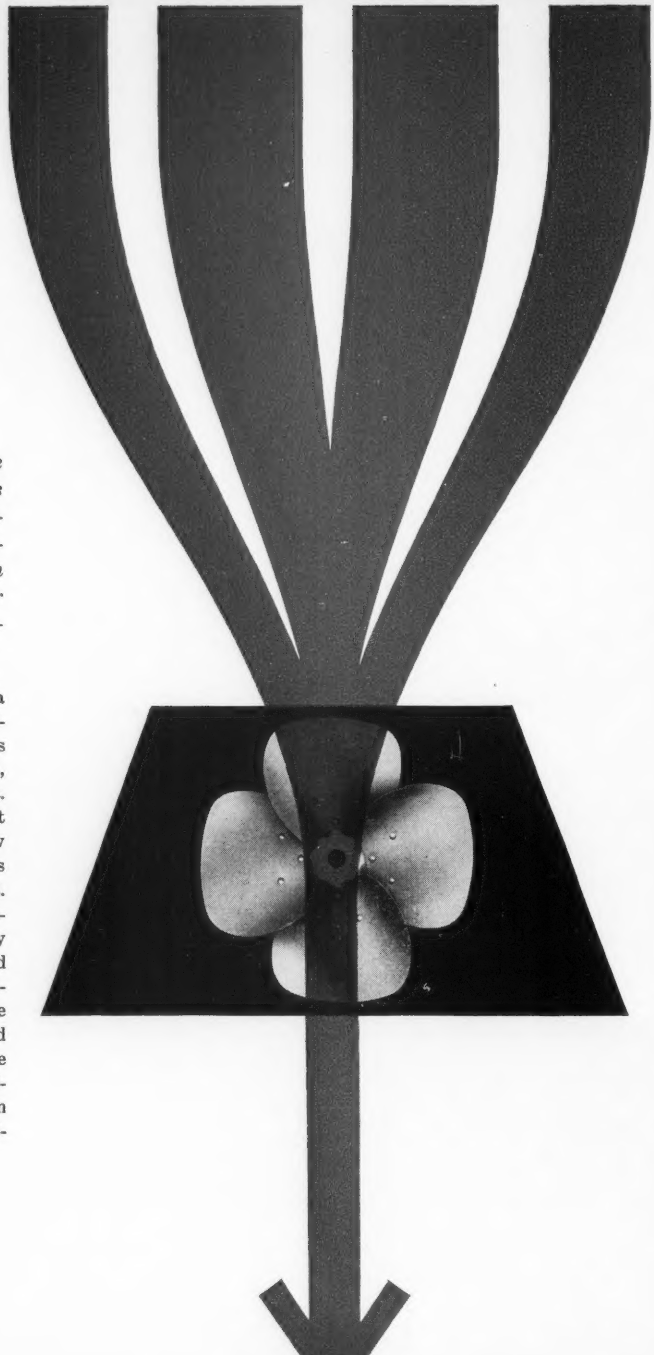
THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED
25 KING ST. WEST, TORONTO, ONTARIO

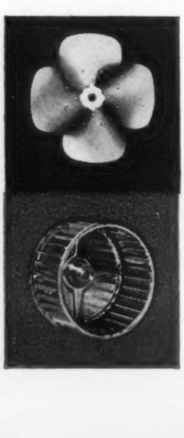
Maximum Air Delivery in Pressure Applications

...that's what you get with the Torrington "P Series" fan blade

Designed for a wide variety of pressure applications, the "P Series" fan blades turns in a top performance in many leading makes and models of modern air-moving equipment. Large blade area in relation to diameter gives maximum air delivery. Available in 10"–11"–12"–13"–14"–16"–18" diameters.

The "P Series" fan blade represents only a small portion of the unusually broad variety of air-impellers which Torrington is currently equipped to produce for heating, ventilating and air-conditioning equipment. This product range, plus Torrington's great capacity, can provide...quickly and at low cost...the fan blade or blower wheel that's best suited to your air-moving requirements. Torrington also maintains a complete research testing service for assistance on any design problem relating to air flow, sound and vibration. This service is always available to you and can be of particular value in the early stages of product design and development. No one has more experience in the design and production of air-impellers than Torrington. Nowhere else can your dollar buy so much in terms of product quality and customer service.





THE
TORRINGTON
MANUFACTURING COMPANY OF CANADA LIMITED
OAKVILLE ONTARIO
TORRINGTON, CONN. VAN NUYS, CALIF.

VIP's

Important people who are in the news

TINNERMAN PRODUCTS INC., the Cleveland firm that manufactures industrial fasteners has a new president. He is **Robert C. Overstreet,** who succeeds **George J. Schad** now retiring.

President Overstreet is familiar with his new job; he has been executive vice-president since 1953 and on the company payroll since 1941. Gradually working his way up, he was named assistant to the vice-president and general manager

Overstreet of Tinnerman

in 1945. In 1948 he became secretary, was later elected to the board.

As new president, he has a big job on his hands guiding the Tinnerman interests which includes Dominion Fasteners Ltd., their exclusive Canadian licensee and manufacturer.

• • •

BIG, SIX-FOOT FOUR Vancouver consulting engineer, **J. L. Miller** is a new celebrity for Canada. At 37, he heads a company of his own and is vice-president of W. M. Armstrong and Partners Limited. A few days ago he watched the opening of Western Canada Pipe Mills, a $6½ million dollar plant in Port Moody B.C., which he designed for the most part. For himself and Richard M. Reiner, Managing Director of the mills, it was the finale to a two-and-half-year dream.

Success moved rapidly for engineer Miller. In May 1953 he had been in practice with B. D. Bohna only six months. To their office came director Reiner seeking the firm's advice on the prospects of constructing a pipe mill in Canada similar to a Chile operation.

The outcome of the meeting manifested itself sharply. On the basis of a market survey and a comprehensive project report a loan was promised by the Industrial Development Bank with the proviso that other satisfactory financial support be found. This provision was met by action from the Reinische Rohrenwerke of Germany in December, 1953. A month later Messrs. Miller and Bohna were retained to prepare partial designs and supervise construction.

Erection of the pipe mills is not a new accomplishment by engineer Miller. He was consulting engineer for the Vancouver Rolling Mills project, and the Victoria and Kitimat plants of Canadian Liquid Air Company.

Designer for 35 service stations for an oil company, a compressor building for its competitor and warehouses for yet another oil empire, aggressive Miller quips: "Dream the biggest, fattest dream you can think of and, in Canada, it can come true."

To those who seem sceptical, he has two simple words of proof: "Mine did!"

• • •

THE ASSOCIATION of Consulting Engineers' new president, **Edgar A. Cross,** has wrapped his life around the engineering profession.

He looks back from his sixty-seventh year on a dramatic career spread among England (where he was born) the U. S. and Canada.

In the U. K. he was assistant engineer of the Birmingham Canal Navigations. From 1915-17 he served with the Chemical Warfare Branch of the Imperial Army, later went into the Research Department of the Royal Arsenal at Woolwich. After his time with the canal operation he headed for the U. S. There he worked for prospering architects on the structures of several hotels.

• • •

After further experience as a design engineer in Detroit, engineer Cross came to Canada in 1927. For the next three years he was retained as design engineer by a Toronto firm.

In his private consulting practice he has designed a number of war plants and several large industrial constructions such as the Frigidaire plant at Scarborough and the Polymer factory at Sarnia.

His experience and qualifications are well directed to his appointment.

A member of various engineering societies apart from his presidency of the consulting engineers organization, white-haired Edgar Cross is also chairman of the Design Committee of the National Building Code.

• • •

BUSINESS IN HEAVY machinery shows good signs of stabilizing itself in the view of **E. R. Snell,** who as new sales manager for the Dominion Wheel Division of Canada Iron Foundries is in a better position than most to judge.

"The last six months have been rather uncertain, but with the easing up of international tensions the big expansion

Dominion Wheel's Snell

programs we are tied in with appear ready to go ahead," he said.

After 15 years' experience in his field his recent promotion gives the firm-lipped sales executive a broad picture of Canadian business in general.

Now, he will oversee sales coverage for all Ontario plants of the company spread from Fort William to St. Thomas. One problem in marketing Canadian machinery salesman Snell observes is the trend of most firms with head offices in the U. S. to specify American equipment.

"It will take some time to put across the design of Canadian equipment, because most companies rely on American specifications although the manufacture may take place this side of the border," he added.

Away from business, he is the friend of many children who rely on his guidance in sports activities at the Invictus Club in Toronto's west end, where he is a past president.


WESTINGHOUSE
Life-Linestarter
RESET

Die punch (centre) compacts loose metal powders (left) to form the auto shock absorber pistons (right).

From a Powder Comes the Product—

Powdered Metallurgy and Iron Sintering Began in Ancient Egypt, was a lost art revived centuries later

By A. J. LAST

ONTARIO RESEARCH FOUNDATION

IMAGINE YOURSELF in Egypt in the year 3000 BC. At the edge of a small town near the shade of the pyramids, there is a small cloud of smoke billowing into the air. Taking a closer look you see a large mound of red iron ore, and you notice that the smoke is rising from a forge equipped with bellows.

You are watching the first production of iron sinterings made by man.

In those days the Egyptians produced iron ornaments and weapons by the direct reduction of mined iron oxide to sponge iron in a charcoal fire. Solid structures were then obtained by forging the porous metal while hot and cold forming the useable shapes. In the following centuries powdered metal sintering was entirely forgotten until it was re-established by Bessemer and Wollaston about the year 1800 AD.

Powder metallurgy was first used commercially when platinum ingots were made by compressing and sintering platinum powder. This was later extended to the production of tungsten billets for the drawing of filaments for electric light bulbs.

It was 1936, however, before iron powder was studied with the object of making molded and sintered parts. Cheap Swedish sponge iron was used and during the last war the production of iron powders and powder parts was stepped up to keep pace with

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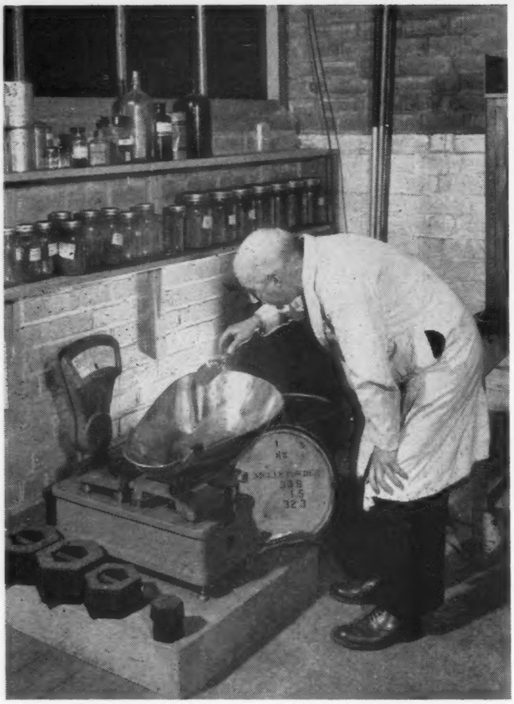
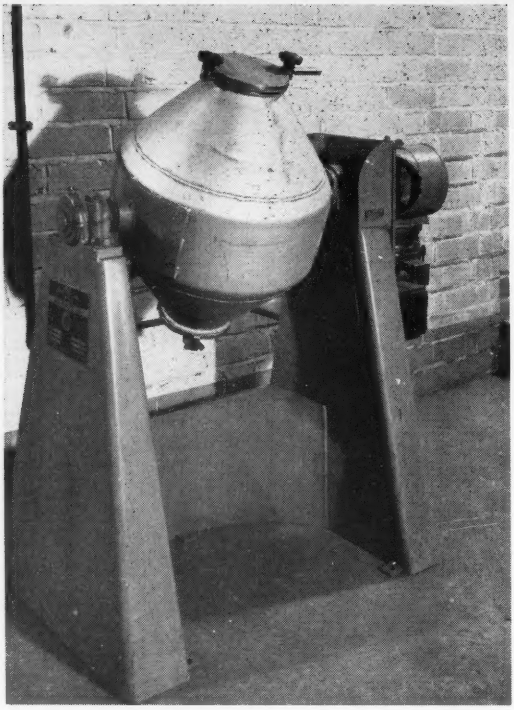


Constituent powders are carefully weighed to give the desired composition in manufacture of alloys.



This machine tumbles component powders for several hours to make sure mixture is truly homogeneous.

Powder metallurgy involves two stages, the compacting and the sintering

expanding industry and new uses for iron powder parts were discovered. Then the technique of powder metallurgy began to leap forward.

What is this art, for indeed it has become an art, of powder metallurgy? Briefly, powder metallurgy is a method of producing certain articles by pressure and heat. Usually these stages are separate and are termed compacting and sintering respectively.

The compacting stage is carried out at room temperature in a die and a press. The die is filled with metal powder and one or more plungers operated by the press enter the die and compact the powder to the required form. This compact then undergoes the sintering process, which is carried out in controlled atmosphere furnaces, the temperature of which may or may not be above the melting point of any one constituent.

Sintering is usually followed by a sizing operation and perhaps by some machining. The sizing may be carried out in a die and press, similar to the compacting, or by coining or broaching.

If dense iron and steel components are needed, a second sequence of pressing and sintering is sometimes gone through. But one sequence will be enough for most parts made this way.

How is the iron powder prepared in the first place? The processes might well be divided into two parts:

1 Physico-chemical processes;
2 mechanical processes.

Iron powders are prepared in three main ways by physico-chemical means.

The most important of these is the direct reduction of iron oxides with reducing gases or solid reducing material that can be gasified. Using iron ores of very high purity, metal powders can be had directly by this method. The general reaction for the reduction of a metal oxide by hydrogen or carbon monoxide is summarized like this:

$$MxOy + yH_2 \longrightarrow xM + yH_2O$$

or

$$MxOy + yCO \longrightarrow xM + yCO_2$$

Sponge iron comes into this category and large quantities are produced in Sweden owing to a reserve of very pure ore. It has a very soft and spongy texture, which is excellent for pressing. The sponge iron processes depend on ores of extremely high purity, since no slagging takes place in the process, and so magnetic concentration of the fine ground magnetites has had to be improved. For some time Sweden has been perfecting magnetic concentrating drums which will leave as little as 0.07% silica as gangue in the final concentrate. This is a remarkably low figure, excelling any other known magnetic concentrating device of similar type.

Another rather similar process is the reduction of mill scale (a waste product from the rolling and forging of billets) by carbonaceous reducing agents after it has been pulverized. This gives a good iron powder but has not the same pressing properties as sponge iron owing to the hardening impurities, manganese and sili-

con, which are still left in the reduced mill scale.

Electrolytic iron is the product of the second of the physico-chemical processes. Iron powder produced by the electro-deposition of iron from a sulphate solution is generally harder than powder produced by reduction. Its density or sponginess can be controlled to some extent by current density, high acidity and low metal ion concentration and the process always results in a pure iron.

The third method is the carbonyl iron process which produces a high cost powder of very high purity having, as a rule, poor compressibility but good sintering properties.

Carbonyls are obtained by passing carbon monoxide over spongy metal at specific temperatures and pressures. It has been stated that only a few per cent of carbonyl powder added to commercial hydrogen-reduced powder can materially improve the product without affecting the cost.

The most popular method

Of the mechanical methods, shotting and crushing and milling of cast iron or quenched steel particles followed by decarburization appear to be the most popular. Atomization is also used to some extent.

The shotting process is interesting. Molten iron in a Bessemer converter is first blown to reduce the carbon to the 0.10-0.50 range and, after slagging, the converter is tipped so that the stream of molten metal is poured onto a rotating steel wheel level with a bath of cooling water in a large round tank. The resulting disc-shaped and porous granules are crushed and pulverized in impact mills and are finally annealed in a reducing atmosphere.

The greatest handicap in the development of the powder metallurgy of iron is the problem of finding high purity powder at reasonably low prices and this has an important bearing on the selection of parts to be made commercially by the powder metallurgy process.

Sponge iron is the lowest priced powder and with new methods of magnetic concentration will be used even more than it is now. Reduced iron powder with a purity of 96-98% iron is suitable for numerous applications in powder metallurgy; the price range is from 7 to 10 cents per pound. Other reduced iron powders, 98 and 99% purity, are suitable where high accuracy and quality are required. American powders are more expensive than imported Swedish powders of approximately the same analysis. Very high quality iron powders, that is, carbonyl, electrolytic and so on, are used for special jobs such as magnetic cores and electrical contacts. Prices range from 15 cents to $1.00 per pound.

To get an idea of the manufacturing scale of U. S. sinterings, figures for 1953 state that the total consumption of iron powder was about 11,500 tons—7,000 tons of which were imported and the remaining 4,500 tons manufactured by American companies. Canada has two companies producing iron powder, Ferrum Ltd., (of Three Rivers, Quebec) which sells an atomized and decarburized iron powder as well as carbon reduced iron, and Metal Powders, Ltd., (Iberville, Quebec) which also sells carbon reduced iron powder.

The press used for compacting may be either mechanically or hydraulically operated and the pressure may be anywhere between 5 and 35 tons per square inch. When two punches are used to compact the metal powder in the die, they are usually arranged at each end of the die and approach each other simultaneously. During this stage the voids between the particles are reduced in size and this increases the density of the bulk of the powder. These voids are reduced by the deformation of particles so that they key into one another, the flattening of surface irregularities and the actual movement of particles.

There have been several theories brought forward

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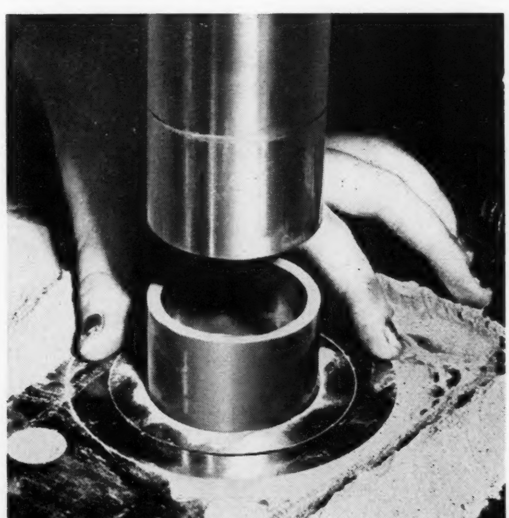
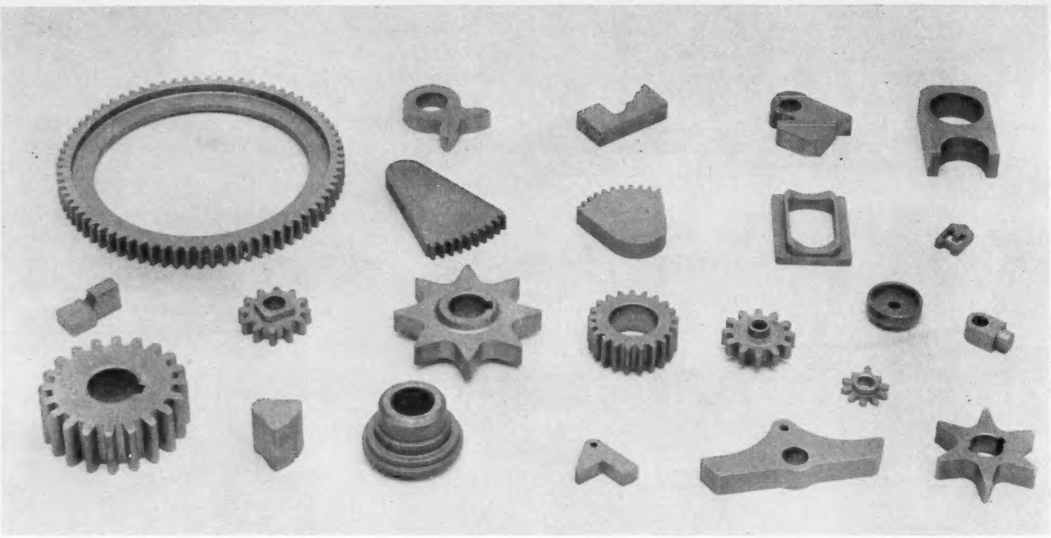
Presses three stories high at Chrysler produce many giant parts such as these heavy industrial bearings.



A large part for bearing which was hand fed into the press emerges from the die-cavity of machine.



Typical steel parts, produced by powdered metallurgy are an example of the shape, sizes, possible.

Powder metallurgy *Continued*

to account for the mechanism of powder compaction. They all agree on one thing, however, that the primary object is to bring enough particles together to produce interparticle bonding which results in the "green" strength of the compact.

The pressing dies used in powder metallurgy have to be dimensioned to allow for contraction or expansion of the compact during the sintering stage. They must also have sufficient depth to contain the necessary volume of unconsolidated metal powder. Usually the volume of the powder before compacting is about three times that of the finished product.

The compacting tools most often consist of a die barrel in which the powder is poured; a lower punch which forms the bottom of the die barrel cavity and which serves as an ejector punch; a core rod extending through the lower punch and die barrel for cylinders; and an upper punch which provides the pressure for compacting.

Since metal powders cannot flow around corners, the tools must be made so that only opposing pressure forms the compact. Sideways movement in the die members has until recently been considered impossible. However, the National Radiator Co. has produced a side slide in a die which enables pressure to be applied from two directions at right angles to each other.

For parts having a variable thickness it is necessary to design die sets so that the various sections can be equally compressed. This is done either by springing the punches or by using multiple punches. The primary concern in compacting a powder must be that the compression ratio (the ratio between apparent density of the powder and the relative density of the compact at any stage of compression) remains constant through the cross section of the form. It must stay constant whether the form is complex or not.

Sintering is the heart of powder metallurgy. It is the process that binds bodies together—using pressure and/or heat. There are four main types of sintering:

- Sintering uncompacted particles with heat.
- Sintering with the simultaneous use of pressure and heat—in other words, hot pressing.
- Sintering compacts. And,
- Sintering compacts with the production of a liquid phase.

Sintering is, in reality, a specialized heat treatment, for it implies the heating and cooling of a metal or alloy to impart certain characteristics of strength and ductility and other physical properties.

Atmospheres are important in the production of iron sinterings. Iron parts need partially burned natural gas (hydrocarbon atmosphere) or dissociated ammonia, that is, ammonia that has been "cracked" into its components, nitrogen and hydrogen. Steel parts, on the other hand, need atmospheres with closely controlled dew points and carbon dioxide content in order to inhibit carbon loss from the compact. Hydrogen is the best reducing gas but owing to its high cost is only used where its benefits override its high cost.

Once the decision is made that there are to be enough parts produced to warrant the high initial cost of powder metallurgy, it should be put before the die-designer or tool maker with the specification indicating the metal, alloy or mixture to be used. If necessary, he will then re-design the part to make it easier to compress and to give an efficient powder flow in the die. If the part is complex, he may divide it into two or more components of simpler shape. The die will be designed next and a temporary set of tools probably made to find the best condition for obtaining the correct densities, and to follow the pressing characteristics of the powder. The clearances and tolerances necessary to meet the specifications will be computed. If a large output is contemplated, the dies may be of carbide, otherwise they will be of die steel, probably chromium plated.

The main object of design is, of course, the economic production of the parts in question. Good tool design plays a major part in the economic battle, but economy can be fostered in many other ways such as by correct care of dies, employing good pressing and

sintering practices and a thorough knowledge of the powder to be used in the process.

It is extremely difficult to give an accurate comparison survey of iron sinterings and low carbon steel owing to the many variables that have already been mentioned. However, taking a large range of density, from 6.5 to 7.5 gms/cc the ultimate tensile strength will vary from 20,000 to 40,000 psi. The elongation on a two inch gauge length varies from 5 to 20%. A normal low carbon steel of density 7.85 gms/cc has a tensile strength of 35,000-42,500 psi and an elongation of 30 to 40%.

Repressing and re-sintering can give properties approaching, and sometimes exceeding, those of low carbon steel, but in most cases the extra step is unnecessary.

Owing to the rather poor properties of sintered pure iron parts, their application is restricted mainly to mild steel machine elements which are usually machined from iron and steel foundry products.

It is often possible to make a complicated shape in one pressing operation which on sintering can be produced to accurate dimensions. This obviates any machining time or scrap wastage. Often a shorter tooling time is required for complicated shapes made by powder metallurgy. Production may be commenced within weeks where tooling by normal machining techniques would take much longer. High rates of production can be maintained; it is quite normal to press at speeds of 1,000-1,200 pieces per hour from one press. Skilled machinists are not necessary for the presses—most of the work is done by unskilled labor. Wear resistance is improved considerably in the case of oil-impregnated low density bearing parts and many special alloys of two immiscible metals cannot be made by any other process.

The size of the parts produced is limited however; length is governed by the travel of the punches and the transverse area of a part is limited by the high compacting pressures. In general, the strength of sinterings falls below that of parts made in the solid, although high-strength parts have been made. Powder metallurgy is seldom applied to the production of parts in small quantities since the cost of the die would be too great a proportion of the total cost of the article. It has been stated that from 20,000 to 25,000 is an economic minimum.

Until recently the use of powder metallurgy has been over-stressed for promotional purposes. This perhaps has been helpful in some measure to enlarge and consolidate markets but has caused many time-consuming, trial-and-error experiments carried out to be sure that particular parts can be made. Today, nineteen years' experience has given metallurgists a better understanding of engineering design problems and the chance to be surer of this modern technique.

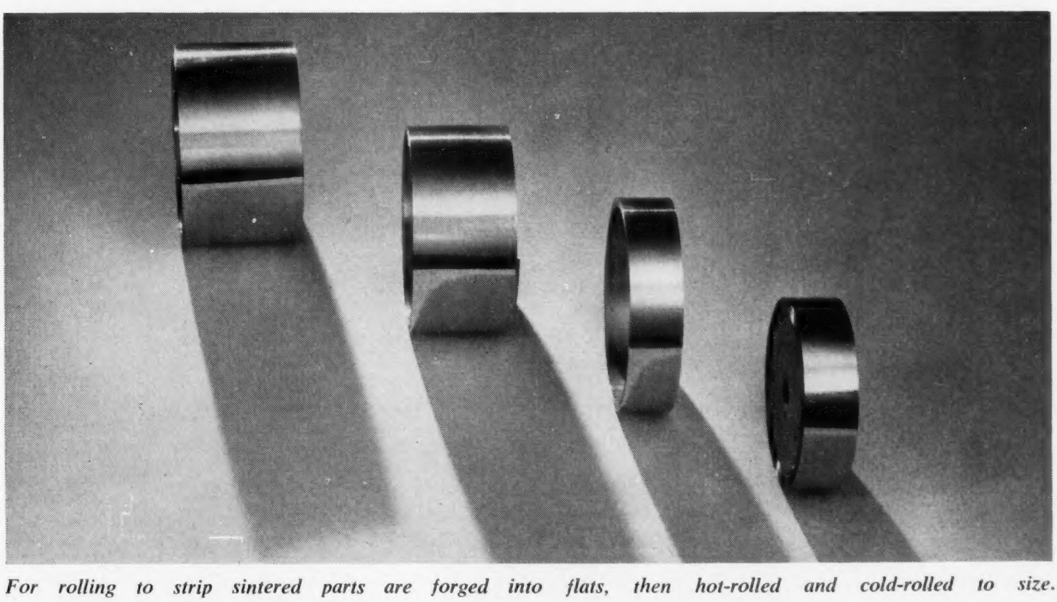
Design flexibility is usually the controlling factor when it comes to choosing methods. It controls not only the early decision of whether to use powder metallurgy or not but also the coining or heat treating operations to be used. A broad understanding of design in drop-forging, sand-casting, die-casting or screw machine operation is essential for engineers designing powder metal sinterings. If the wrong process is used it can lead to serious failure.

Even with every processing care, powder metallurgy cannot yet be used for very high-stressed parts—such as transmission gears; but there is still a vast potential market for the method. We need only a few manufacturers to look at its uses with their eyes wide open and we shall soon see that present powder metallurgy ideas, big as they are, have just got started. Powder metallurgy has much growth ahead of it; and as it grows it is going to bring new wealth to industry.

This wealth has already asserted itself in a rising pyramid of new alloys made by the powder metallurgy process. By this method powdered metal can be mixed with other powder materials without any risk of the ingredients separating in the melt.

Who can say what this will lead to? Very high temperature alloys made by powder metallurgy are planned for use in jet engines and similar alloys have already been applied to rocket projectiles. ★

Metallurgists today have better design understanding through experience



For rolling to strip sintered parts are forged into flats, then hot-rolled and cold-rolled to size.

High power and good rpm of the Solar Mars gas turbine coupled with portability make it an ideal firefighter

Midget Turbines Offer High-rpm Power

An engine that is small and compact, light in weight, your gas turbine is capable of high power and good rpm. Watch it move ahead in industry soon

WHEN A JOB calls for a small, compact, quick-starting engine that is light yet delivers good horsepower with plenty of rpm, the Solar Mars Gas Turbine may be the answer.

Weighing less than 100 lbs with an output of more than 60 hp, this gas turbine operates at 40,000 rpm on high octane gasoline, jet propulsion fuel or diesel oil.

It has been designed to fulfill the need of a prime mover in many branches of industry. The most notable application to date is its use as a prime mover for the U. S. Navy's original type P-500 portable water pump set. The unit has also been used to power a 14 kw auxiliary generator set on the C-124C Douglas Globemaster and the C-121C version of the Lockheed Super Constellation. In both cases the unit is used as a source of electrical power, either on the ground or in flight.

Other versions of the Mars Turbine have equal promise. The T-41M-5 and -6 units, designed to provide somewhat higher power at altitude, have just been announced and have been ordered by Convair for their C-131B flying electronic laboratory. These turbines, mounted in fiberglas pods under the wings, will power radar and other special electronic gear.

Another Mars turbine, the T-60M electric starter cart—a ground support unit for starting jet planes—was unveiled at the Dayton Air Show last summer and is currently undergoing cold weather evaluation. Compressor bleed air versions of the Mars and other variations still under wraps are also going through development and test. Each of these variants of the basic engine can work under a wide range of temperature and climatic conditions. All are compact, lightweight, and quick-starting and can be equipped with automatic control as desired.

Simple as it is, the gas turbine presents design difficulties if there is any reduction in the size of the components. Due to the aerodynamic problems and loss of efficiency, it is just not practicable to scale down a gas turbine below a certain size.

But an outstanding advantage to the design engineer is the fact that a small gas turbine in terms of pounds per horsepower is much less than that of a piston engine of comparable power output.

There are maintenance advantages too. The engines

are easier to work on than the piston type and, besides this, less maintenance is needed. There are fewer moving parts and movement is rotary instead of reciprocating which means less rubbing friction.

If it is properly designed, the gas turbine's willingness to start is not affected by changes in temperature and altitude. Against this, of course, it still eats a lot of fuel; its consumption does not yet compare with the piston engine's. But the simplicity, light-weight, and reliability of the well-designed small gas turbine make it a natural choice in many cases where fuel economy is not the big worry.

Another of the outstanding advantages of the gas turbine is its flexibility of design.

In the piston engine, the major processes of the operating cycle—compression, combustion, and expansion—are carried out in a single structure: the cylinder. In a gas turbine, they are performed by separate components. This allows wide latitude in the choice of type of compressor, combustor and turbine for the gas turbine plant. The designer's initial problem is properly to orient the plant power requirements in the order of their importance. The best arrangement can then be chosen.

The selection of compressor is a major decision for not only has it a profound effect on performance, but it is a governing factor in cost. The centrifugal-flow compressor is more compact in length and weighs less for the same capacity than the axial type. It is less sensitive to dust and corrosion, and is cheaper to produce.

The axial compressor, on the other hand, offers higher efficiencies and greater pressure ratios in a single unit and is smaller in diameter, with lower rotational speed. The axial turbine, too, has a smaller overall diameter than the radial turbine. It can be more readily staged for high pressure ratios and a lower speed of rotation.

The radial turbine gives equal or better stage efficiencies in smaller sizes without requiring the precise and difficult manufacture of aerodynamic shapes. It is shorter in over-all length, is relatively insensitive to dirt and contamination, is extremely rugged and costs less to produce.

Table 1—Mars G/T Fire Pump

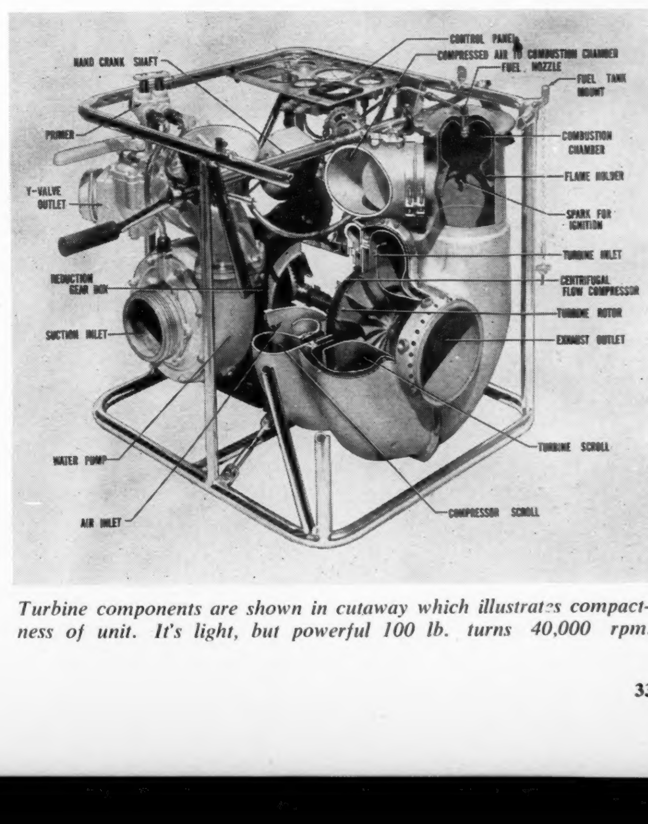
Total dry weight less tank and hoses	175 lb
Over-all dimensions	27 x 24 x 25 in.
Rated power output	45 hp
Turbine speed, full load	40,000 rpm
Pump speed at rated capacity	4,500 rpm
Pump output with 16 ft suction lift	500 gpm at 100 psi
Fuel	Diesel, gasoline, jet fuel or kerosene
Fuel consumption, full load	104 lb/hr

Fewer limits dictate the shape or location of the combustor, but it is still one of the most critical maintenance items and the turbine engine must be designed so that the combustor is accessible for quick servicing.

There are, too, mechanical limitations in producing scaled-down parts. The cost of having to pay meticulous attention to detail is high. Precision is an absolute necessity—not only in manufacturing tolerances and alignment of bearings, gears and shafts rotating at extremely high speeds, but in surface finishes and contours of aerodynamic shapes exposed to high velocity air streams as well. By a suitable choice of components and by shrewd design, the number of expensive precision parts can be kept down.

Because of the nature of its operating cycle, a simple gas turbine performs most effectively at a constant speed. However, a turbine can also be designed to give power at variable speeds by incorporating a "split wheel" or a separate turbine wheel driving the power output shaft. With this type of design, the small gas turbine becomes an even **(Continued on page 64)**

Engineer easily holds the Mars Turbine which is smaller than a two-foot cube.



Turbine components are shown in cutaway which illustrates compactness of unit. It's light, but powerful 100 lb. turns 40,000 rpm.

Installed in an executive's office, this Marconi Monitor with a control unit on top shows conveyor motion.

Wired TV is an Extra Eye for Designers

By LEO WALTER

CONSULTING ENGINEER (GREAT BRITAIN)

It will look around corners, peer into inaccessible plant operations

INDUSTRY, always faced by the difficult problem of viewing dangerous or inaccessible operations, has found the solution during the last two or three years in industrial television (ITV). Now it is possible literally to see around corners. The eyes of a camera can draw right up to a furnace burning near the observer or bring to the monitor screen distant happenings. The observer can tune in on a single operation or events at several points. He can do this with safety, convenience and centralized supervision. At one time limited by mirrors and lenses, he can now delve into the very core of an operation and watch every phase of activity.

In the forefront of industrial television are several prominent British firms. After a slow start these firms are now ready to serve industry in general and machinery builders and users in particular with ITV. Among makers of new first-class equipment of British design who have gone far ahead in the technological side of British wired television are: Marconi's Wireless and Telegraph Co. Limited; Pye Limited; Emitron Limited; and Cinema-Television Limited (Cintel). Components available from these and other firms in England are almost standardized units. The wiring between is simple, as is camera adjustment and maintainance.

The possibilities for the use of industrial television by the design engineer are many. He can watch the performance of a newly designed tool, machine, apparatus and equipment in general under test without leaving his office. A camera can be placed temporarily in the test department of the plant with a monitor in the design office.

One natural use for the industrial camera and the monitor screen in machining operations will come with fully automatic operation (automation). Once centralized supervision of automatic operations has been decided upon, centralized checking becomes paramount; without it, rejects produced by failure of an electronic device might off-set the cost-savings made. An instantaneous appreciation of trouble with the help of the ITV camera may very well save more in a single case, than the initial cost of the equipment.

In many cases the installation of remote viewing

equipment will be no luxury but a "must," when automation has become widespread. The same applies to certain mechanical handling operations, where increased speed and greater safety call for "seeing around the corner." Finally, ITV is regarded in Great Britain as a most important gadget for helping technical education.

The Ford Motor Company provided an example of wired television at last year's Productivity Exhibition, to which scenes were transmitted direct from the factory, including the milling, boring and drilling of cylinder blocks for the Ford Zephyr.

Emitron Limited have just brought out some high-class equipment for industry which is very suitable for televising machining operations and for demonstration and educational purposes. The type is a miniature version of the well-known CPS. Emitron camera used by the BBC. Lenses are of the standard film type, (35 mm) and the highlight brightness range is from 10 to 100,000 ft-lamberts. The control panel can be mounted on wall or standard rack, and electronic zoom magnifies the picture to twice normal size for close inspection. A waveform monitor is built-in and the output may be directly connected to one or more British standard television receivers unmodified.

Coming forward quickly

ITV is quickly coming forward in technical education. The National College of Rubber Technology in London, has led the way by installing wired television made by Pye Limited. The college is completely wired for television in every lecture room and there are facilities for 180 students to watch TV pictures showing complicated machinery in the basement at work, whereas at the most, three or four might have crowded round it. A similar outfit is in operation in the research department of one of the largest British chemical manufacturers, where it is used to control machinery previously controlled by a series of mirrors which, owing to distance and vibration and other factors, never worked satisfactorily.

It will also interest works engineers to know that during the opening ceremony of the new Rolls Royce factory outside Glasgow, visitors could inspect the engine test beds in complete safety from some distance away. Two ITV cameras at the bed transmitted from a radio mast, 30 ft high, to a second mast (of the same height) erected on the roof of a canteen where the pictures were shown on the TV sets having 27 in. screens.

Tests on machinery will be viewed on monitor screens at the Chulangkorn University at Bangkok, Thailand, where a low-power Marconi television station has been installed. Students unable to find seats in the main lecture theatre, or unable to get near the demonstrations, can watch the lecturer in another room.

Here are a few of the ways that television has proved itself to be an important and, in some cases, indispensable aid.

To save duplicating their experimental model shop in a new factory at Streatham, Smith Meters Ltd. manufacturers of gas and electric meters, have installed a closed-circuit television system, consisting of a television industrial camera and monitor—installed in the model shop—and a receiver which is situated in the design staff room in the new factory block. By installing what is claimed to be the first permanent television system for inter-office use, the manufacturers hope to save their design staff the inconvenience and loss of time that goes with traveling to and from the model shop to answer design queries. The television camera is mounted on a mobile stand so that it can be moved to shoot in any position. In practice, the camera operator puts the object in question in front of the camera, rings the designer on the internal telephone and points to whatever he wishes to discuss. The industrial television equipment was manufactured and installed by Pye Ltd., and has provision for a lens magnification of 10:1.

Several combinations of ITV equipment are possible, of course. A single camera can, for example, produce images on several screens or alternatively several cameras can be located where the pictures are of interest and can be rapidly switched to a single monitor screen in the top executive's office. So in a larger works, the chief design engineer is able to follow prolonged tests of new designs in one or several workshop departments without leaving his desk.

The uses of industrial television are almost unlimited. It can be used in the control of dangerous foundry and rolling mill processes, the observation of hazardous milling and machining operations and the inspection of inaccessible places such as gun barrels, insides of tanks, and cylinders, castings, borings, factory chimneys and grain elevators. Another use is the readings of dials and gauges in dangerous and difficult positions. Industrial television also has its place in viewing tests involving high temperature, voltage, speeds or other personal dangers, such as control panel study of combusion conditions inside furnaces and chimneys.

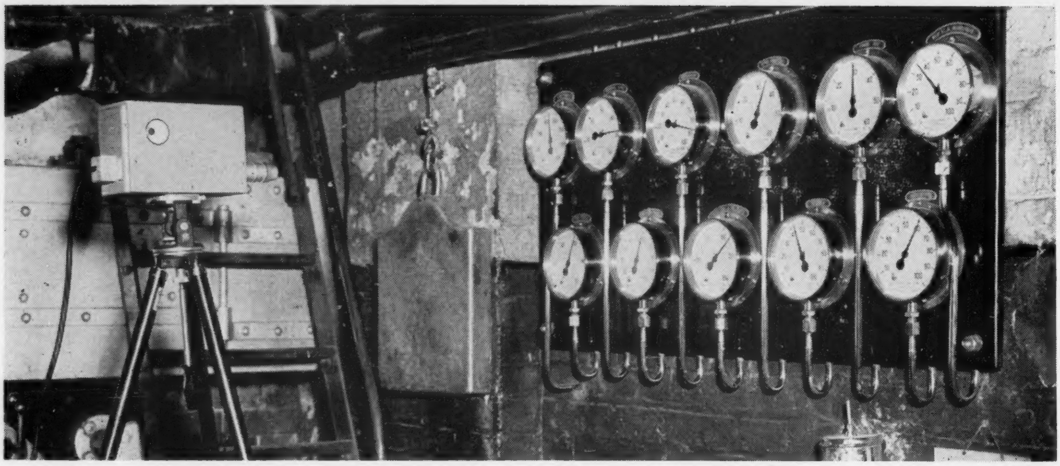
ITV will provide a close-up view to crane operators in loading and unloading ships, as well as railway trucks and other vehicles. It can be called upon in railway marshaling and the observation from the bridge or other section of a large ocean-going ship during docking or other manoeuvring. Concealed positions of aircraft on airports will be revealed to the control tower.

In the field of research, ITV will aid in all types of telemetering. A prime use will be the viewing of experiments involving possible explosions, radio activity and other hazards. Minute objects will be counted by its use and very close or lengthy observation of experiments presents no barrier.

Small or inaccessible objects by the use of ITV will be shown to large classes, or a lecture may be relayed to several classrooms simultaneously.

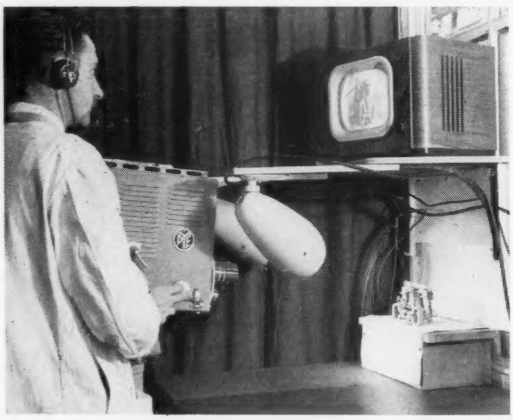
Special work may be viewed by an executive in his office and the same situation holds for a process or experiment being carried out on the factory floor, workshop or laboratory. Records and signatures may be checked over considerable distances and sales items in shops will be exhibited at a central point. A factory or business premises may be visually toured by visitors from a reception room by industrial TV and personal contacts in general will be improved by the use of ITV in conjunction with the telephone.

Developments are very rapid in the production of new, smaller and lighter television cameras, and of larger and cheaper monitor screens. What today seems rather elaborate and costly may tomorrow become simple low-priced and essential. Certainly this is a design and production tool of the future. It is a safe guess that as industry gets to know it better and use it more it will grow cheaper and better. The day may soon come when management wonders how some industrial problems were ever solved at all without the help of wired TV. ★

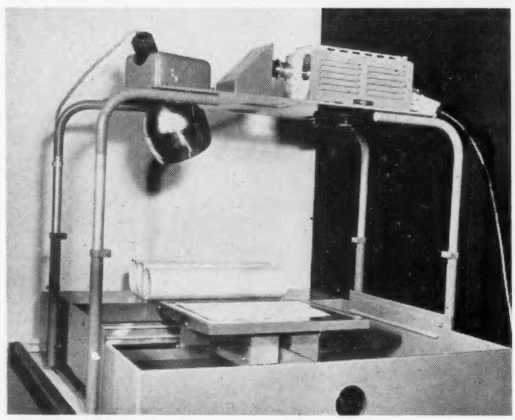


Dial readings are watched by the eye of the Marconi camera and transmitted by wire to observers elsewhere

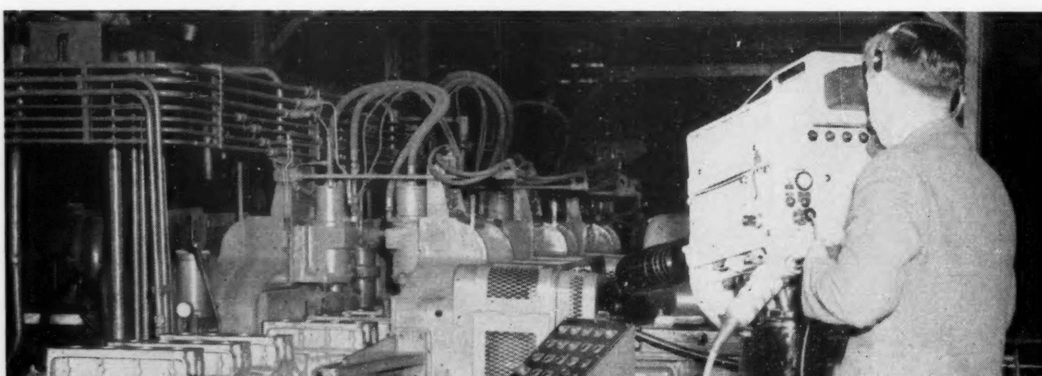
Trained on a variety of situations, industrial TV will miss nothing



Communication between the design office and the Chief Engineer is simplified by the use of industrial TV.



All departments can apply ITV to visually transmit documents from a central point to several locales.



A British design Cintel camera is shown transmitting from the Ford factory production line in Kent.

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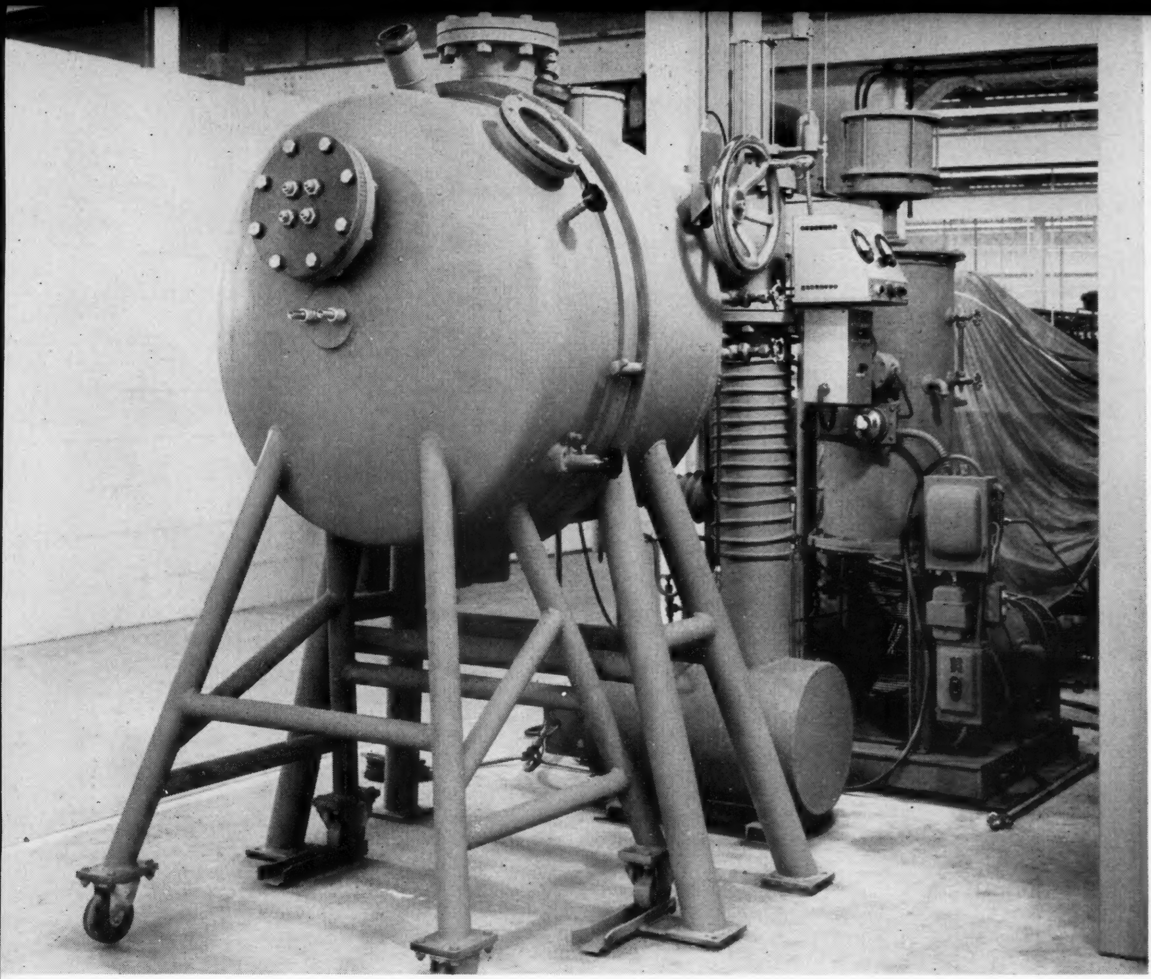


This new modular-design vacuum furnace by Consolidated Vacuum Corporation will produce 5 to 50 lb melts.

High-vac Metallurgy Is Racing Ahead

The vacuum furnace meets demands of tomorrow in new modular concept

VACUUM FURNACES AND THEIR auxiliary gear designed for today's industrial needs may be quite inadequate tomorrow!

The reason: The fast growth of high vacuum metallurgy. In looking ahead furnace designers are facing the problem of older operations becoming obsolete by designing furnaces which can be adapted economically for higher capacities and technological improvements.

Modular design using "building blocks" or modular units seems to be the answer for quick capacity expansion and adaptability.

A furnace like this is already in production by Consolidated Vacuum Corporation. Designed as a lab-size melting and casting furnace it may be modified to meet future conditions. At the same time, a large production size furnace is being built by the company to the modular pattern.

Vacuum processing removes many harmful ingredients from the melt to give a quality product not possible by other means. In alloy production, the vacuum technique permits the introduction in exact quantities of the additives required to produce the desired physical characteristics. Useless oxidation of the expensive alloy materials is eliminated.

Lower-grade base materials, processed in vacuum, produce equal, or higher quality, products than by conventional methods. In forging operations, vacuum metals are found to require much less ingot shaving. These shavings, in turn, also yield a much higher salvage ratio than the shavings from air-melted ingots. Grinding operations are largely reduced because a vacuum-cast ingot usually possesses better surface characteristics. Rejection of finished parts processed by vacuum are reduced many-fold due to the elimination of porosity, which is so harmful in forging, drawing and stamping operations.

Effects of gases in metals has a definite adverse effect on the fatigue behavior, impact strength, embrittlement and ductility characteristic, creep resistance and rupture strength, to mention the most important items.

Consolidated Vacuum recently introduced to the metals industry a new 5 to 50 pound high-vacuum melting and casting furnace. This laboratory furnace is designed for metal producers who are investigating high-vacuum processing of old and new alloys—particularly the high-temperature alloys now in great demand by aircraft-engine manufacturers. The first unit is in operation at International Nickel Company, West Virginia.

The induction heating unit is mounted in the permanent part of the furnace chamber and is so positioned that the crucible can be easily charged with the chamber open or through an overhead port with the chamber closed. There is a choice of five crucible sizes to accommodate melts of 5, 12, 17, 30 and 50 lbs. Three different sizes of high-frequency power supplies are adaptable to this furnace, with 4,200 cycles-per-second recommended for general use.

General process observations, alloy additions, tilt-pouring, crucible temperature-measurement, bridge breaking, pressure readings, and high-frequency control are conveniently located at a unit point of operation. And all vacuum-line valves are pneumatically operated with a single semi-automatic rotary switch used to control "load," "rough-" and "fine-pumping" sequence.

Pressures as low as 10 microns can be created (0.01 mm Hg) in the furnace by means of a two-stage diffusion-ejector pump. The crucible heating elements, pouring mechanism, alloy-addition port and vacuum connections are all contained in a stationary chamber. A feature of the furnace is a rollaway chamber cover which seals against the stationary chamber and contains the mold and power lead-through for mold-heating.

Replacing this cover section with another of different design allows practically every type of melting and casting to be accomplished without revising the vacuum system each time.

Expansion due to technological progress is a certainty in vacuum metallurgy. Only five years ago, batch-type melts of 50 lb in high vacuum were extraordinary. Today 1,000 lb melts are common. Metallurgical engineers are designing 10,000 lb furnaces and talking about "continuous" operation.

The quick growth of high vacuum metallurgy and the accompanying risk of equipment growing too-soon obsolete, is forcing designers to think very carefully.

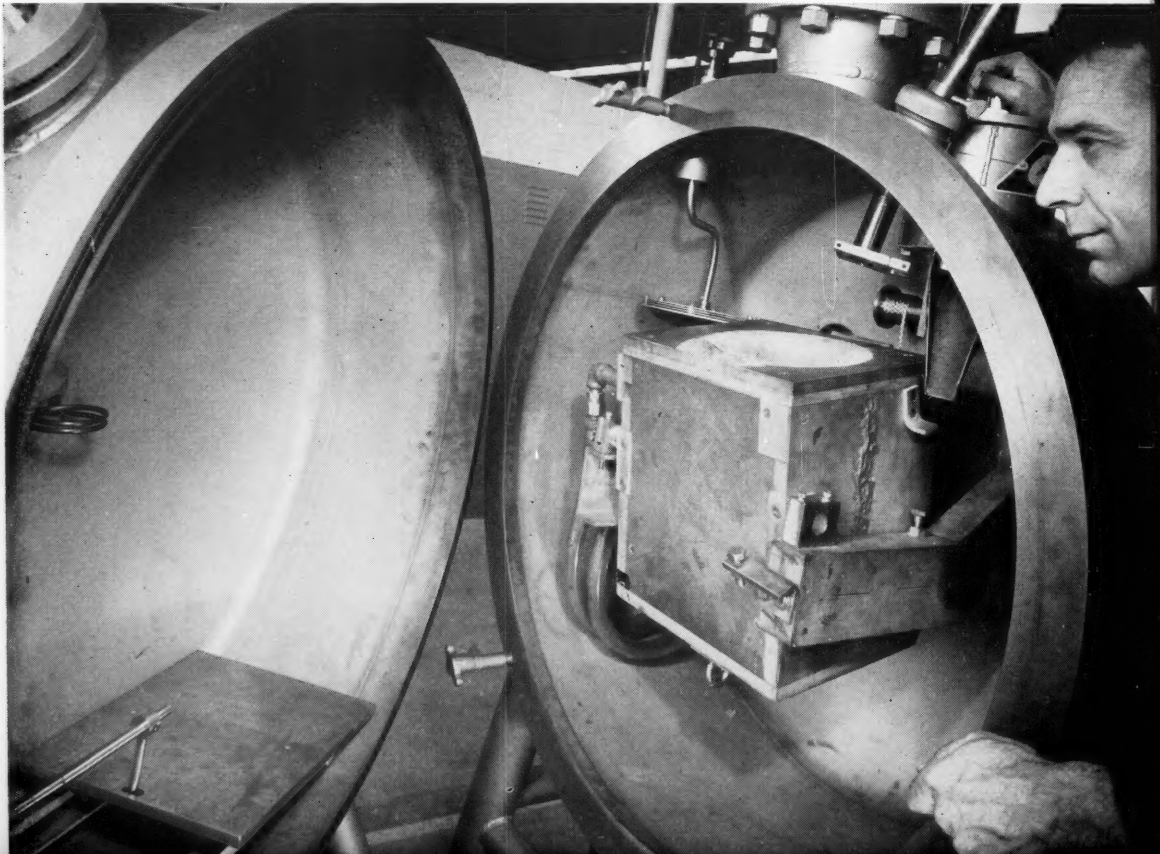
Allow for later increases

Dr. Robert G. Ulrech, Director of Engineering and Development (of Consolidated Vacuum) says the most logical solution seems to be high vacuum furnaces made big enough for today's needs but designed to allow for capacity increases later on; and the furnaces should be adaptable to varied melting and pouring methods.

Flexibility can be designed and built-in initially at relatively small cost, so it would seem wise to make provision for such expansion and adaptability. This can be done by designing the furnace in "building blocks" or modular units. Ulrech feels the major design considerations should be:

- The permanent part, or centre section of the vacuum chamber should be designed to handle the maximum crucible capacity.
- The permanent auxiliary equipment (the vacuum pumping system, for example) should be attached to the centre section and provision made for future attachment of other auxiliary equipment.
- Those parts that have to be changed to provide great-

Inside view of laboratory melting and casting furnace showing crucible, heating, pouring, alloy-addition.



er capacity or allow use of different techniques, should be designed for economical change-over.

Vacuum furnaces designed on the modular principle have been completed at Consolidated Vacuum and are now installed at Westinghouse Electric Company, Blairsville, Pennsylvania, and Carboloy Division of General Electric Company, Detroit, Michigan. The Westinghouse furnace will handle 350 lb. batch melts to start off, but can then be increased to 1,000 lb. capacity. The furnace can also be converted to semi-continuous operation simply by the addition of the required auxiliary equipment. The Carboloy furnace has a capacity of six 1,000 lb ingots poured in series without breaking the vacuum.

One or two pumps needed

Ulrech says that to increase the pumping capacity to that necessary when the furnace is used for 1,000 lb melts, only one and possibly two additional 16 in. diffusion-ejector pumps would be required. For the 350 lb capacity, one such pump appears to be enough. The furnace now being built includes three vacuum pump ports or flanges as part of the design, to provide sufficient vacuum pumping capacity for a variety of applications. Ports which are not to be used to begin with are blanked off with steel plates and can be put into use easily whenever another pump is added.

Flexibility of casting techniques is provided by interchangeable bottoms for the vacuum chamber. These bottoms make it easy to clean the chamber, simplify repairs in the event of spillouts, and make it possible to use alternative casting methods.

Semi-continuous operation is provided by interlocks, through which the crucible can be charged, the alloying elements can be altered or adjusted, and the ingots or casting removed without breaking the vacuum in the main chamber.

The potential of vacuum processing seems unlimited when one considers such items as magnetic materials, electronic components, bearings and bearing races, resistance wire, and tool steels in which greater service life and improved performance are the primary consideration.

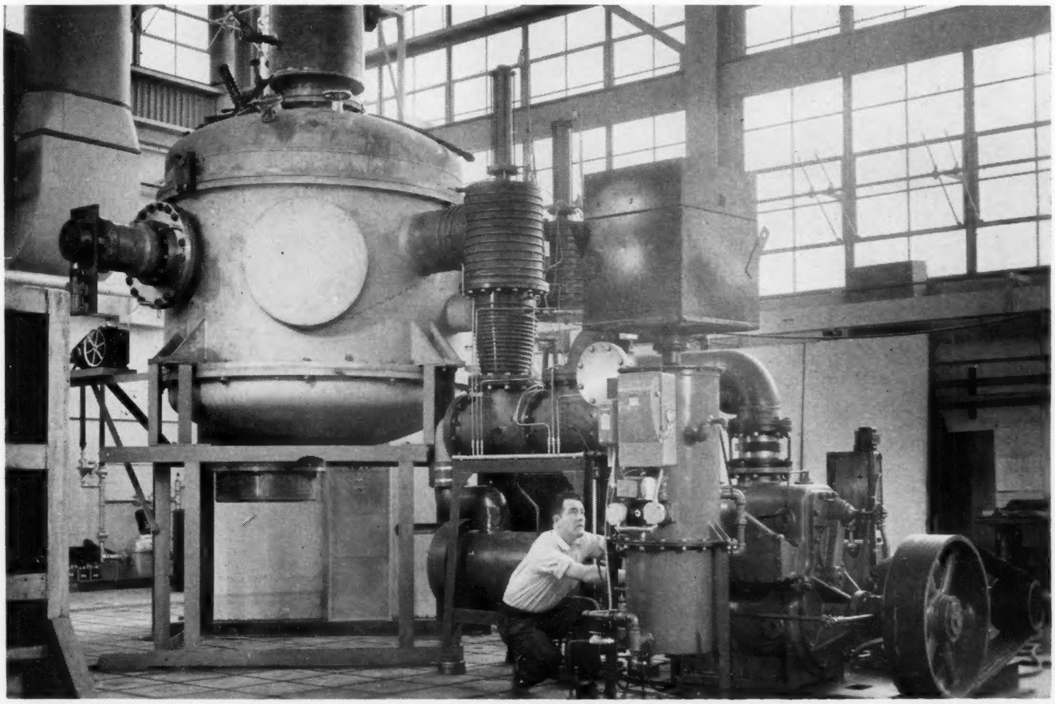
When military needs for higher operating temperatures, better creep strength, stress rupture properties, greater impact strength and less embrittlement have to be faced—vacuum processing steps forward. It is the only process which can meet demands for alloys of this sort on a production-line scale.

Design engineers have found that application of a high vacuum furnace to a research problem ensures purity of result and also cheapens the cost of alloy production.

The furnace, of course, is but one part of the whole vacuum field. Historically, the first vacuum work began to enter industry with the manufacture of the Edison lamp, and later in the radio vacuum tube. Today's television tube could not be made without the vacuum process.

Because of vacuum work's advancement, the manufacture of drugs such as penicillin and Salk vaccine was made possible. Blood plasma, which could be kept only a matter of weeks can now be preserved for years.

Although these scientific advancements remain a second cousin to the work done in metallurgy by the high vacuum furnace it is easy to see that the vacuum process has rooted itself in the core of industry. ★



A final check is made of a CVC 350-1,000 lb. furnace before it is installed in a Westinghouse laboratory.

Stress Lofting Diffuses A Point Load

By M. C. W. DAVY
DE HAVILLAND AIRCRAFT OF CANADA LTD.

It is a method quick enough to help the designer still at project stage

HOW DO YOU diffuse a point load in a structure of stringers and metal sheets? The question has had a lot of attention since the adoption of stressed skin construction for aircraft.

It is usually easy enough to visualize the load spreading across a wider and wider cross-section until it is fully diffused and to know from this roughly how to position the structural material. A sensible (and possibly economical) guess can be made from experience. But a precise attack on the problem is more difficult. It may take a long time to prove mathematically that there is a proper margin of safety; in fact, it may take so long that the design will have grown up beyond the stage where changes can be made.

The ideal state of affairs is to be able to establish the equations of compatability of strain and of panel equilibrium, using these either to set up a pattern from scratch or to confirm an assumed pattern of shear diffusion. But such a process will become unwieldy unless the structure is idealized by assuming uniform panel size and skin gauges, or by neglecting taper in the flanges. Should the concentrated load be applied to a flange member that lies at the junction of three webs, as is the case for the mainspar flange of a two-cell wing, there will be added complications.

A quick method

There is a method which is quick enough to be of help to the designer still at the project stage. Consider the case shown (picture 1). The cylinder has 8 equally spaced "flanges" connected by webs. For simplicity, all the flanges are assumed to be of equal area and without taper, and the webs of equal gauge. It will be shown later that the general case of unequal, tapering flanges adds little in the way of complication.

The concentrated load at section 1 appears wholly in flange 1—as such, section 1 will be distorted from its original plane to a great extent. Proceeding "upstream," the load will be diffused by shear in the webs into the adjacent flanges, until at section 4 the diffusion can be assumed as complete. So, section 4, originally a plane normal to the axis of the cylinder, may now be considered as having bent to an inclined position, though still remaining plane. Now the section can be examined by the normal theory of bending, which gives the stress in a flange element:

$$f = \frac{P}{A} \pm \frac{Mz}{I}$$

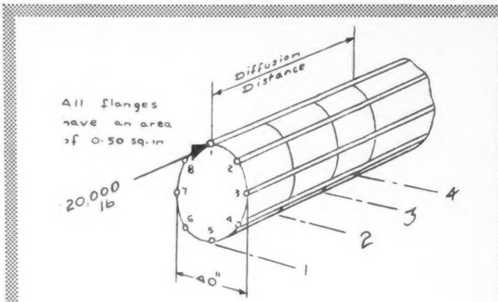
The load in the flange will be:

$$P_f = f \times a_f$$

where a_f = area of flange.

The flange loads at section 4 and sections farther upstream have been calculated in table I.

The flange loads are known at the beginning and at the end of the diffusion region. If the cylinder is developed, as in picture 2, and ordinates are erected to represent flange loads, the problem becomes one of



In the project stage engineers find stresses with equally spaced flanges.

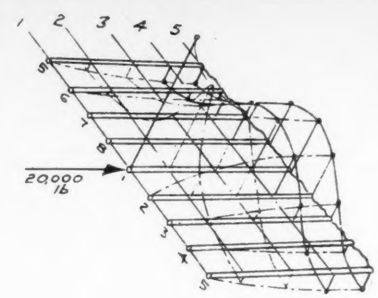
fairing the fully diffused loads of section 4 into the single load at section 1. For this the normal loft techniques may be used, in which "buttock lines" of load, running axially, are reconciled by repeated trial with transverse section profiles until each is a smooth curve. The smooth continuous load surface means that the necessary requirement of consistent strain has been met.

Having faired—in a tentative shape, the result may now be checked by examining the equilibrium of the intermediate sections 2 and 3. This is done quickly by reading-off the axial loads in the flange members at each section. These loads may then be added algebraically together with the products $p_f z$. For equilibrium, the following conditions hold:

$$\Sigma p_f = 20{,}000 \text{ lb.}$$
$$\Sigma p_f z = 400{,}000 \text{ lb-in.}$$

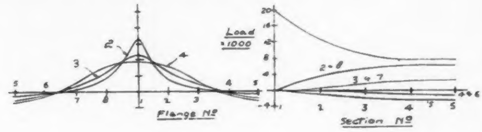
This has been done in tables 2 and 3. It will be seen that at section 3 the end-loads add up correctly, but the resisting moment they provide is low, while at section 2 both Σp_f and $\Sigma p_f z$ are low. A correction is made in a second cycle of operations, the section profiles being modified accordingly. For example, section 3 must be lifted in the central region and dropped at each end, so that there is an increase in resisting moment without any change in total end-load. Section 2, on the other hand, should be lifted more in the centre than it is dropped at the ends, so that both resisting moment and total end load increase. These modified profiles may now be faired to give smooth buttock lines of load and the equilibrium checked again.

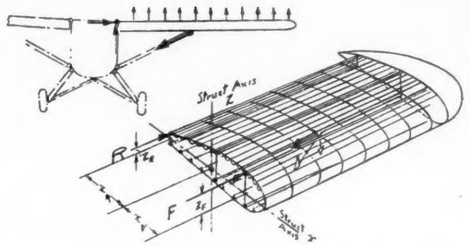
Should the structure be more realistic, with flange members unequal in area and webs unequal in thickness, the same principles may be applied with only a small change. The following example outlines the procedure used for examining the attachment loads at the root of a stressed-skin, strut-braced wing. Picture 3 shows how the inclination of the strut produces an outward thrust at the two root-attachment points. The setup is unusual because the lift strut is attached to the bottom boom of *(Continued on page xx)*



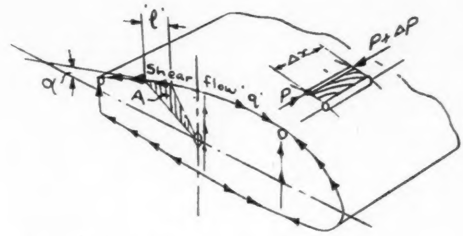
Left, ordinates are erected to show flange loads at one point, not several.

Below, buttock lines run axially in normal lofting technique.





Angle of strut produces outward thrust.



Fairing process shows the effect of web.

Examples here show the application of stress lofting in practical cases

Calculation of flange loads

Flange No.	Area 'Af'	z	Af.z²	P/A	$\frac{Mz}{I}$	$F = \frac{P}{A} \pm \frac{Mz}{I}$	F × Af = Pf
1	.50	+20.00	200.0	+5,000	+10,000	+15,000	+ 7,500
2	.50	+14.14	100.0	+5,000	+ 7,070	+12,070	+ 6,035
3	.50	0	0	+5,000	0	+ 5,000	+ 2,500
4	.50	—14.14	100.0	+5,000	— 7,070	— 2,070	— 1,035
5	.50	—20.00	200.0	+5,000	—10,000	— 5,000	— 2,500
6	.50	—14.14	100.0	+5,000	— 7,070	— 2,070	— 1,035
7	.50	0	0	+5,000	0	+ 5,000	+ 2,500
8	.50	+14.14	100.0	+5,000	+ 7,070	+12,070	+ 6,035
Σ	4.00		800.0				+20,000 ✓

∴ $A = 4.00$ in² & $I = 800.0$ in.⁴

$$\frac{P}{A} = \frac{20,000}{4.00} = 5,000 \text{ lb/in}^2$$

$$M = 20,000 \times 20 = 400,000 \text{ lb-in}$$

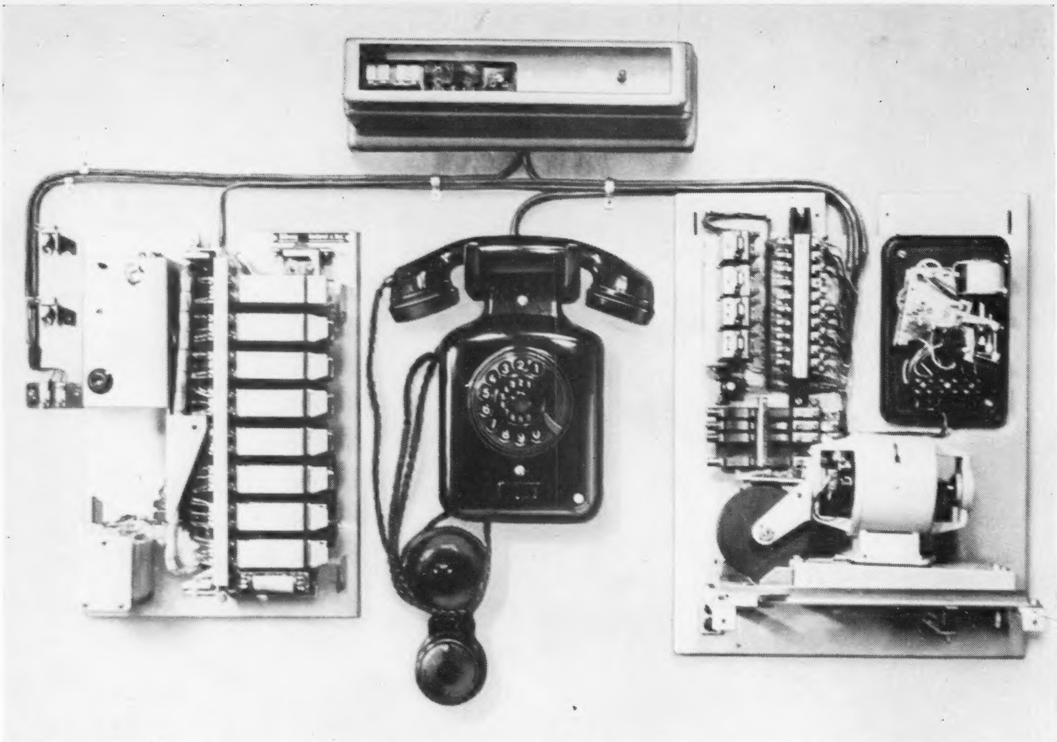
Check:— $\Sigma P_F = P$

Section 2

Flange No.	P_F	z	P_F.Z
1	+12,800	+20.00	+256,000
2	+ 3,500	+14.14	+ 49,500
3	+ 600	0	0
4	— 250	—14.14	+ 3,540
5	— 1,200	—20.00	+ 24,000
6	— 250	—14.14	+ 3,540
7	+ 600	0	0
8	+ 3,500	+14.14	+ 49,500
$\Sigma P_F = +19,300$		$\Sigma P_F.Z = +386,000$	

Section 3

Flange No.	P_F	z	P_F.Z
1	+9,000	+20.00	+180,000
2	+5,500	+14.14	+ 77,800
3	+1,800	0	0
4	— 800	—14.14	+ 11,320
5	—2,000	—20.00	+ 40,000
6	— 800	—14.14	+ 11,320
7	+1,800	0	0
8	+5,500	+14.14	+ 77,800
$\Sigma P_F = +20,000$		$\Sigma P_F.Z = +398,240$	



Using the regular telephone system, this automatic warning device is on the alert 24 hours against emergencies.

This New German System Weds The Telephone And Auto-Alarms

By ROBERT GERWIN

SPECIAL GERMAN CORRESPONDENT

On guard constantly, the automatic warning pinpoints trouble economically

BECAUSE AUTOMATION has mostly done away with resident staffs at radio relay stations, pumping stations and other similar installations, there is the new threat of an emergency passing for too long unnoticed.

But now, in Germany, a system has been devised and put into use which gives an alarm automatically through the public telephone system in event of trouble.

Previously, a special telecommunication system with its own network was used. This method was not only complicated but was also costly, since alarm systems are used so rarely.

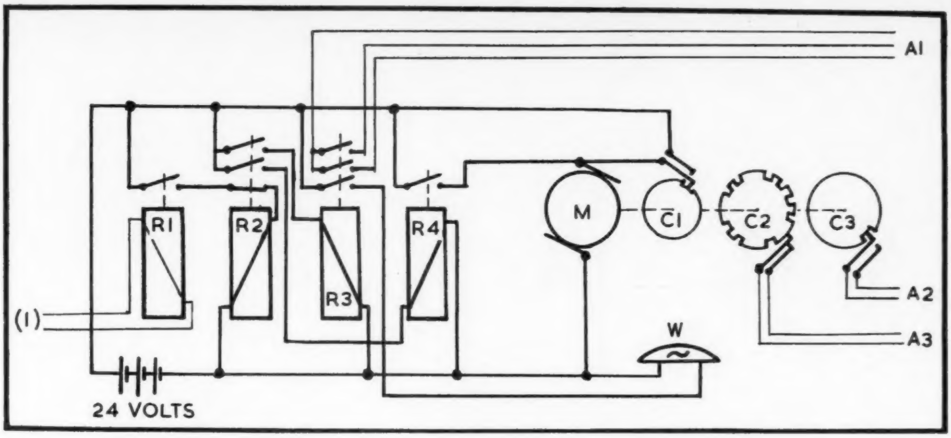
Installed in the waste water sewer system in Berlin where a controlled level of the water must be maintained at all times, the device, built by the De-Te-We (Deutsche Telefonwerke und Cabelindustrie), will automatically set off a buzzer and send out dialling impulses over the telephone. When the receiver is taken off at the other end, the control station staff officer hears the buzzer warning him of danger.

All irregularities must be transformed into electric impulses in the effective operation of the warning system. This is accomplished by the overheating of a motor, which closes a bimetal contact, or a change in the water level in which case a float moves a switch.

These impulses arrive via the connection (1) and attract the Relay (R_1)—see picture. This attracts the deferring relay (R_2). The same circuit is interrupted at once as (R_3) and (R_4) are put into operation. The same action as lifting the telephone receiver by hand is carried out by ordinary Relay (R_3).

At this stage the buzzer begins to hum and the deferring relay (R_4) puts the motor into operation and falls off a moment later. The motor gets its current via the contact on the cam plate (C_1). After one revolution it stops by itself. During this time the dialling impulses are sent out by the interruption of the contact on the cam plate (C_2).

When the station being dialled fails to answer the



German automatic warning device

R_1 Impluse arrives at this first deferring relay from connection (1).

R_2 This deferring relay is attracted by R_1. After several minutes it falls off breaking the telephone connection. If the trouble is still not over R_1 is still attracted, which further attracts R_2 as the process is repeated.

R_3 When this relay is attracted by R_2 it carries out the same movement as lifting the receiver, at the same time sounding buzzer.

R_4 Puts motor into operation and falls off momentarily.

M Then motor turns cam plate which sends impulses traveling to A2 and A3, the regular telephone lines.

C_1 By contact interruption cam plate begins dialing out sequences which are followed by the actions of cams, C_2 and C_3.

When the control station officer takes off his receiver he is alerted by the buzzer hum coming through the microphone at the automatic warning installation.

If several stations are on the network each buzzer produces a different hum to identify the station in difficulty. Several kinds of trouble may be reported by special humming interruptions, or by dot and dash.

relay actions are repeated and stop only when the irregularities are corrected by themselves, or an engineer turns a key in the unmanned station.

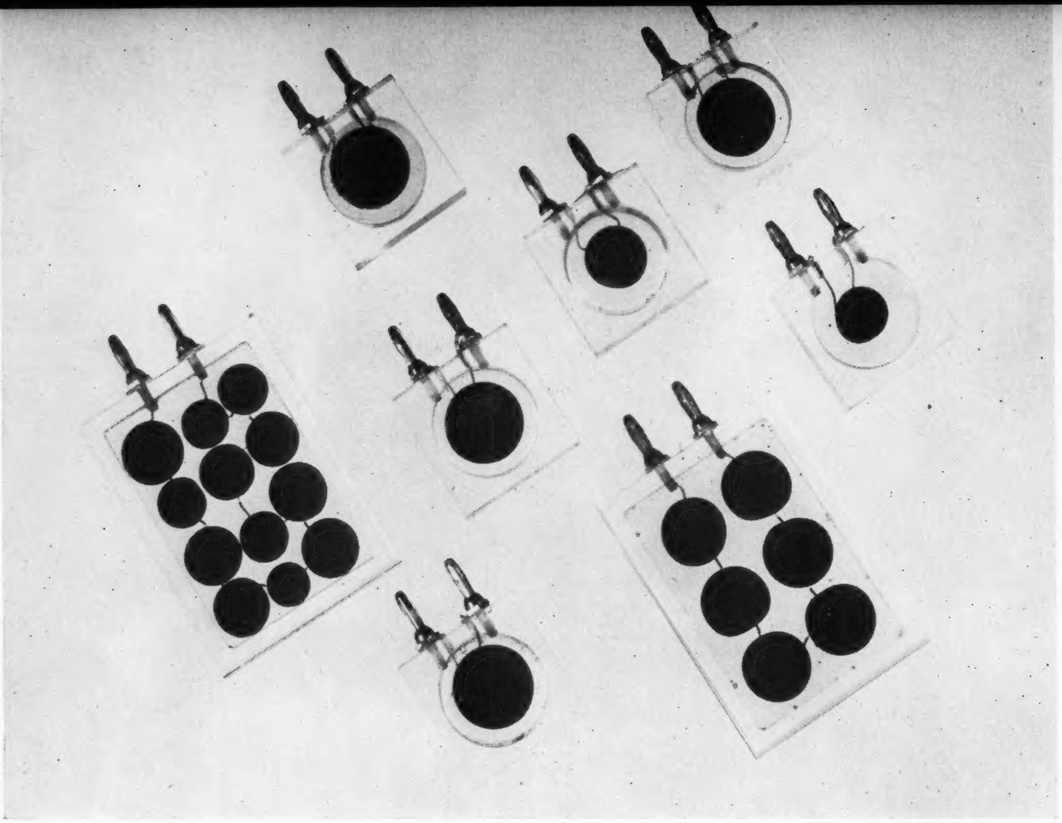
Each buzzer produces a different type of humming since one officer controls several stations. Through the use of an additional installation (not shown in diagram) it is possible for the device to indicate several kinds of trouble by dot and dash.

This installation has proved effective in its first few months of use in several stations. Adaptable to all situations where it is necessary to transmit control reports from time to time, the warning device is expected to replace many expensive communication networks in the future and developments are well under way.

How far has the use of automatic warnings gone then in Canada?

The Bell Telephone Company has established alarm control centres across the nation tuned to micro-wave relays. One control centre maintains a vigil over 12 stations. Some troubles are merely reported and others are correctable temporarily by pressing buttons in the centre. Pressing other buttons will locate the nature of the difficulty and its severity.

Another range of equipment known as telemetering and control can be applied to warning systems if the customer requests it, a Bell official indicated, but there is no automatic warning to parallel the system that has been installed so successfully in Berlin. ★



These Bell Solar Batteries, although still strictly a lab device, are earmarked for future communications use.

Bell Finds Power from the Sun's Rays

Still in the experimental stage, Bell Solar Battery ushers a new scientific era as engineers harness energy from the sun, then store it for later use.

Six important facts about the Bell Solar Battery

1. The Bell Solar Battery is an experimental device that converts sunlight directly into electrical power, with no intermediate steps.

2. It is at least fifteen times more efficient than the best previous solar energy converter, which makes it the first real solar power supply.

3. It has no moving parts or corrosive chemicals, and therefore should last indefinitely.

4. Its efficiency of conversion of available light remains essentially constant even in poor light where other types of converters will fail.

5. It charges a storage battery at constant voltage, and a solar battery-storage battery combination can thus average a steady power output through days and nights, over periods of good and bad weather.

6. It is a result of the same research and development effort that produced the transistor at Bell Laboratories, and it is particularly adaptable to modern circuitry.

SCIENCE'S LONG SEARCH for an efficient method of converting the sun's energy into a more useable form has resulted in the Bell Telephone Laboratories' solar battery. Although it is still strictly a laboratory device, its potential uses mark it as an achievement of much importance.

In communications and in many other aspects of modern technology, the Bell Solar Battery, which can convert as much as 11% of the sun's energy, will find increasing usefulness. Its performance is greatly superior to that of other types of photo-sensitive cells. Bell scientists claim it is fifteen times more efficient than any previous solar converter; and its efficiency remains constant even in poor light.

The Bell Solar Battery owes a great deal of its success to its co-inventor Daryl M. Chapin who began intensive study of solar power in 1953.

He investigated direct conversion of solar energy into electrical energy and applied his findings to the invention of the solar battery.

At present he is making broader tests and improve-

ments in the prototype. From these experiments greater efficiency has been added to the original unit.

Work by Calvin S. Fuller of the Laboratories led to a technique of diffusing impurities into the surface of a silicon wafer. This was a key achievement in the preparation of the battery.

As early as the 1930s, R. S. Ohl and J. H. Seaff of the Bell Laboratories noticed that the P-N junctions were photosensitive. It remained for later engineers to apply their observations in a workable form.

This solar battery then is the nearest answer!

It consists of a number of individual silicon solar cells, each of which can convert sunlight into electrical power.

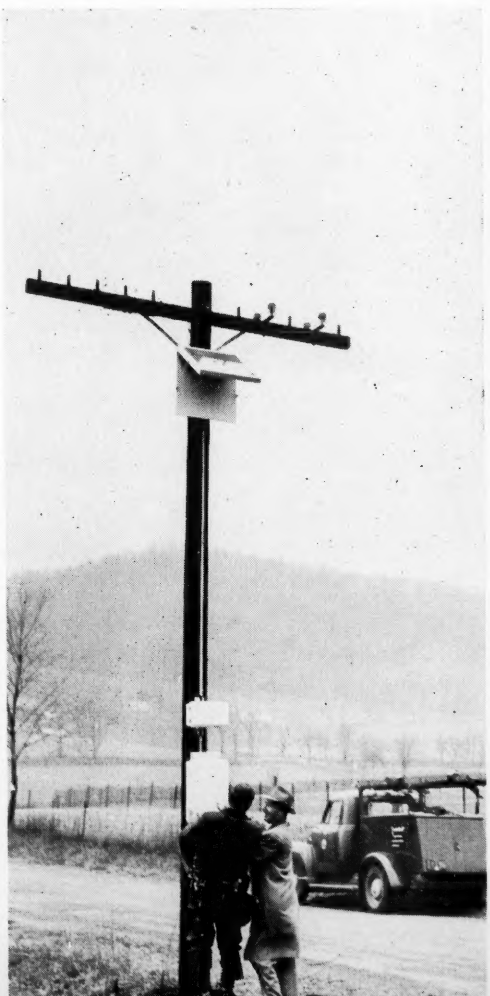
The heart of a solar cell is the P-N junction between different electrical conductivity types in a semiconductor crystal (see DESIGN ENGINEERING, May issue). Photons of light energy, when they strike a semiconductor, will often split off an electron from its normal position in the crystal lattice, leaving a positively charged "hole" or vacant space. Both the electron and the hole will then be available for the conduction of electricity—if they can be prevented from recombining and thus neutralizing each other. The P-N junction provides a built-in electric field that pulls the electrons into the N or negative side of the junction and the holes into the P or positive side before many of them recombine. The electrons and holes are said to be "collected" by the junction. With suitable contacts and leads to the two sides, the resultant current can be used in an external circuit. The actual conversion of light energy into electrical energy is therefore seen as occurring in the creation of "electron-hole pairs," a process that becomes significant under the influence of the electric field of a P-N junction.

The solar cell, illustrated here, is thus simply a P-N junction designed to take the best advantage of these phenomena. The junction is made very large and is oriented to face the sun, and the top layer is made very thin so that as many as possible of the effective photons may penetrate to the vicinity of the junction.

With silicon, the effective parts of solar energy are absorbed in the outer 1/1000 in. layer and, to be collected, the electron-hole pairs must be produced within about 1/10,000 in. of the junction. In addition to these fine tolerances, we also have the requirement that the surface must be highly conductive. Much of the electrical power would otherwise be lost through heat generated from the internal resistance of the cell.

The answer to the problem of producing the battery grew out of a study of diffusion into solids. Diffusion methods proved to be ideal both for controlling the depth of the outer layer and for achieving high surface conductivity, and boron was found to have many advantages as the diffusing element. In this particular case, temperatures must approach the melting point of silicon (1,400 deg C), and the relationship between diffusion time and depth of diffused layer must be precisely known.

One method of forming the P-layer is to heat a



Above, a Bell engineer compares the electrical output of battery with total energy available from the sun's rays.

Left, experimental work on the Bell Solar Battery has proven that it can someday supply power to rural telephone lines.

Below, a co-inventor of the Bell Solar Battery, D. M. Chapin, holds solar device which turns wheel on ledge beside it.

Solar battery *continued*

plate of N-type silicon to a high temperature in the presence of a gas containing boron. The boron is broken out of its chemical compound and diffuses into the silicon. The depth of diffusion is determined by the temperature and by the length of time the diffusion process is allowed to proceed.

This process results in a decreasing concentration of boron with increasing depth. Right at the surface, the silicon is very heavily "doped" with boron. Further into the crystal the concentration decreases until, at about 1/10,000 in., it gets so low that the N-type, arsenic-doped silicon of the body of the crystal predominates. This change in conductivity type defines the position of the junction. Deeper into the crystal beyond the junction, boron concentration drops to zero. The different numbers of arsenic and boron atoms at the various depths create an electric field gradient which, as mentioned earlier, collects the electron-hole pairs.

After the diffusion process, there still remain the important problems of providing suitable contacts and of encasing the entire structure to protect it against rough treatment and weathering effects. Both problems must be solved in such a way that the cell will show good electrical characteristics over a long period of time. The diffusion process has left a piece of silicon that has the P-layer on all sides. As implied by the drawing, the P-layer is removed from a portion of the bottom surface and makes contact to the body of the crystal. Contact to the P-layer then completes the electrical arrangements.

The thin P-layer is so easily penetrated that making contact by alloying or welding techniques is impracticable. The original solar cells were constructed merely by brushing layers of metallic lacquers on top of copper-plated sections of the cell, but such contacts tended to deteriorate with time.

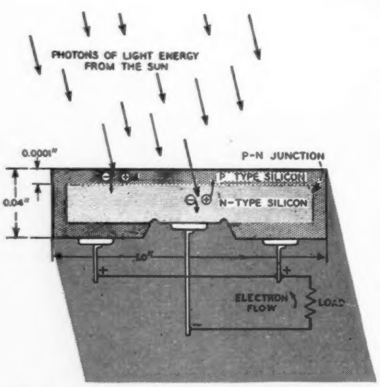
As a result, many other methods were tested such as, metallic layers produced by oven firing, electroplating, and metallic vapor deposition. Additional work and long-term testing will be required before the best type of contact is determined, and the same may be said of the problem of encasing the structure. To date, cells have been encased in solid blocks of clear plastic and in blocks of plastic with liquid and gas-filled centres. Various shapes and sizes have been used, some with the clear plastic molded into the shape of lenses in attempts to get the best focusing of solar energy on the surface. Development work has resulted in several promising methods of making contacts and of providing encasements.

Since hazy or partly cloudy skies are more transparent to infra-red than to ultra-violet, the sensitivity to infra-red also shows that poor light conditions are not necessarily a deterrent to the cell's utility. If a day begins with a dark overcast and then gradually improves to admit progressively larger amounts of sunlight, we notice the changing characteristics illustrated. Here we have plotted a cell's short-circuit and open-circuit voltage against percentage of total sunlight. The current rises linearly, but the voltage quickly jumps to its maximum value.

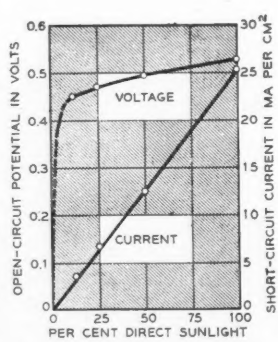
These curves represent only the extremes of open- and short-circuit conditions. In between, for different external loads, we can plot a power curve of the sort seen. Under full sunlight, the cell's power reaches a peak at a voltage somewhat lower than the best open-circuit response. This optimum power point is the one used to determine the cell's efficiency, here about 6%. This value was obtained at an operating temperature of 25 deg C. At higher temperatures the output voltage drops off, but the current increases, so that the change in efficiency is not very great over a reasonable range of operating temperatures.

For sunlight values less than 100%, similar power curves are obtained, with the peak power always occurring at about the same voltage—that is, at about 0.3 volt per cell. This means that a constant voltage device, such as a storage battery, is almost the perfect load for a solar battery over a wide range of sunlight values. The efficiency remains essentially unchanged. ★

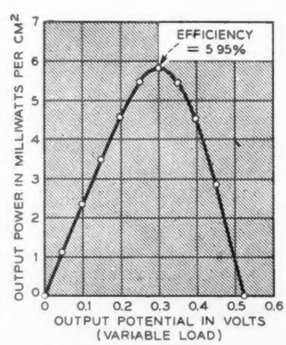
Characteristics of the Solar Battery



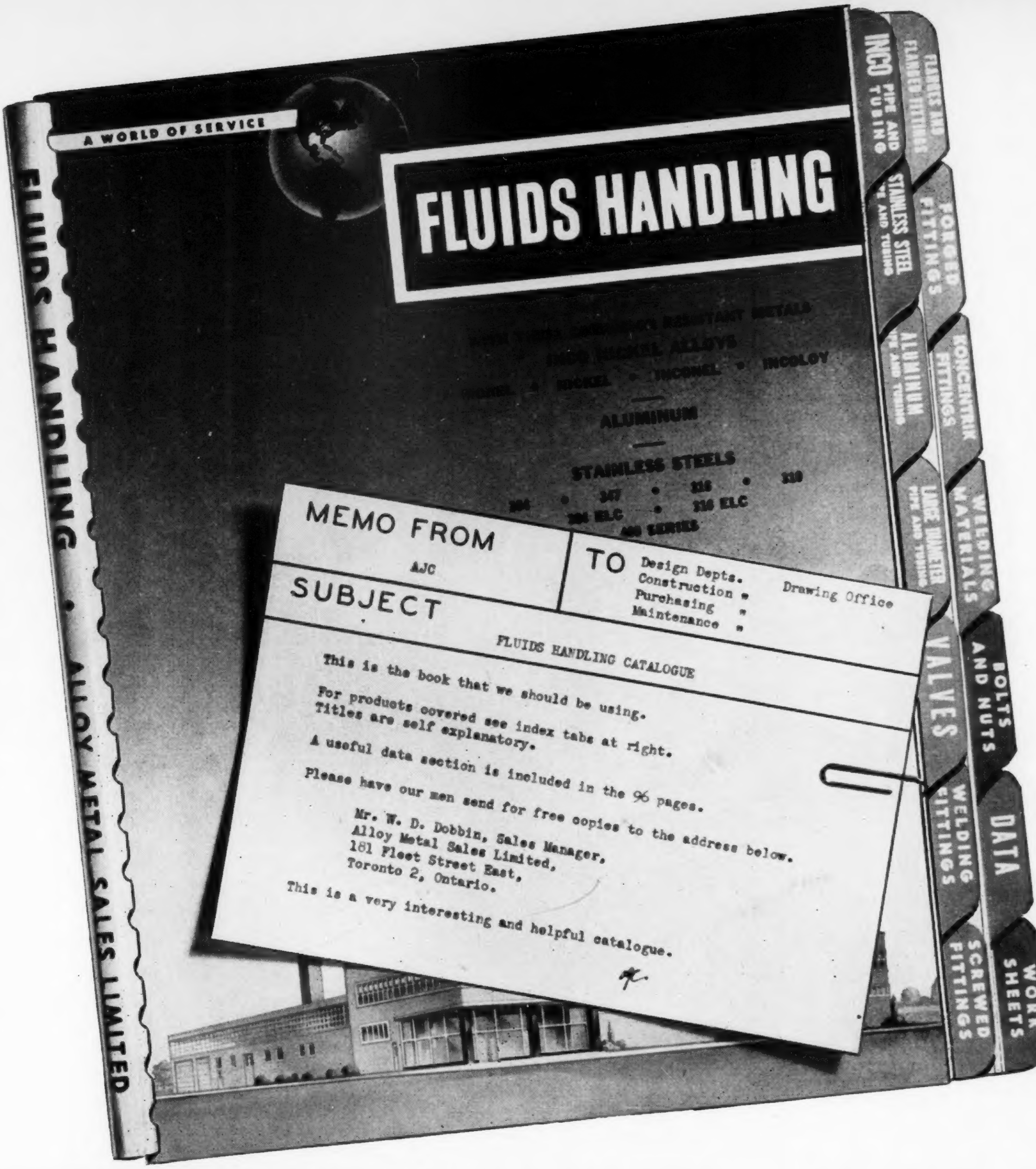
This cross-sectional view of a plate of silicon prepared as a solar cell shows the electron hole pairs made by photons.



Open circuit voltage and short-circuit current in relation to sunlight at 25° C.



Solar cell output for various external loads are shown here at 25° C., in direct sunlight.



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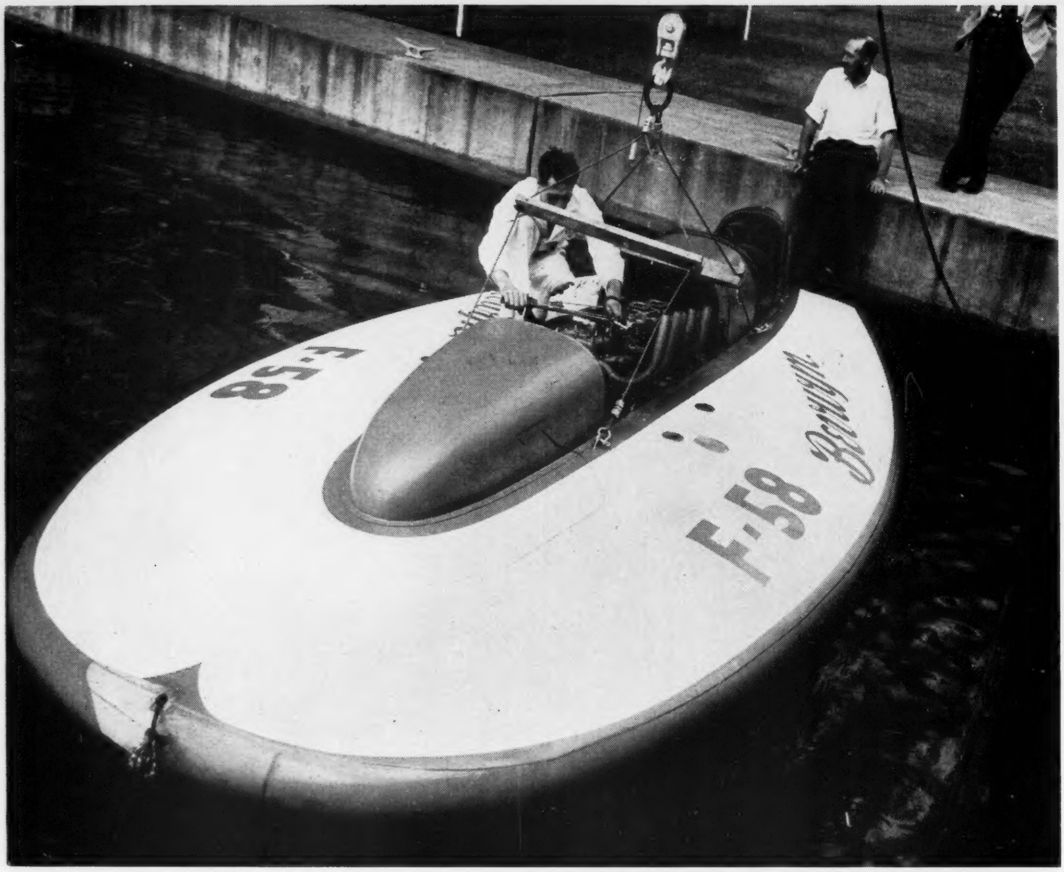


Vinyltoluene answers many marine problems because of its resistance, offers more features than Dow styrene.

Synthetics Lead to Broader Horizons

Vinyltoluene paves road for development of new synthetics in plastic realm

By LEON DAVIS
SPECIAL U. S. CORRESPONDENT

TOLUENE, WHICH IS USED to make TNT and is a solvent in the rubber, lacquer and munitions industries has found new uses in a chemical called vinyltoluene.

This raw material for the plastics, synthetic rubber, paint and varnish and other industries is now available to industry for the first time. It is being produced by the Dow Chemical Company in a new plant at Midland, Michigan.

The latest in a series of Dow monomers, vinyltoluene is similar to older and better known styrene in chemical behavior. It is expected to prove especially useful in the paint industry where it reacts to form clear, useful paint vehicles with all commercially important drying oils. One anticipated result of the use of vinyltoluene in this industry is the development of many new paints and finishes.

Styrenated vehicles have provided the protective coatings industry with a substance possessing a number of important properties (such as fast drying, excellent color, good dielectric properties and improved resistance to water and chemical reagents), but they have had limitations. For example, styrene cannot be easily formulated with a number of the lesser reactive oils to form homogeneous products, and styrenated vehicles exhibit very limited solubility in certain thinners. The use of vinyltoluene in the coatings field already has given rise to a class of coating materials in which the two shortcomings found in styrenated vehicles are said to have been almost eliminated without making any great changes in other properties.

Vinyltoluene can be reacted with all of the conventional drying and semi-drying oils to form products of excellent clarity. This permits the paint chemist to take full economic advantage of price fluctuations characteristic of vegetable oils used in the manufacture of coating materials. The price of these oils varies from season to season, depending upon a number of economic and climatic conditions.

Coating vehicles containing vinyltoluene can be

classified into two general categories: vinyltoluenated alkyds and vinyltoluenated oils. The former exhibit all of the properties generally associated with styrenated alkyds such as lacquer type drying, good gloss, excellent initial color and color retention, good durability and satisfactory chemical resistance, the company said.

Vinyltoluenated oils represent a class of vehicles which combine the flexibility and adhesion of the oil with the hardness, color retention and a measure of the chemical resistance of the polymer constituent. These vehicles, the company feels, should fit into the architectural type finishes in such applications as maintenance paints, trim and trellis enamels and lawn furniture finishes.

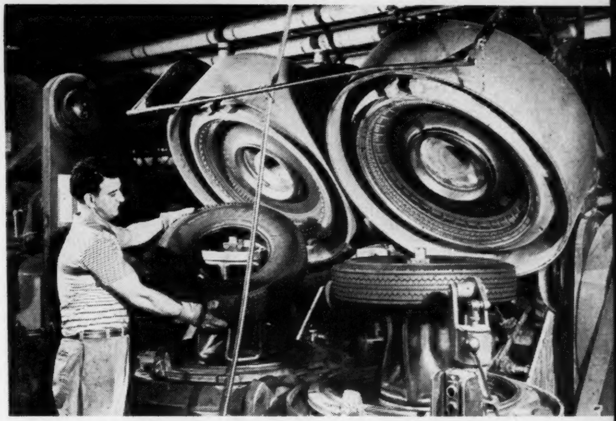
Clear colorless vinyltoluene, like styrene, the starting material for the clear plastic, styron, will polymerize to form a solid plastic capable of being softened and molded when heated.

Styrene and vinyltoluene resemble each other in other respects. Both monomers can enter into chemical reactions with other compounds that are unlike themselves. Both will react with butadiene to make synthetic rubber. However, aside from drying oils and coating materials, another field where vinyltoluene may prove superior to styrene is in polyester resins, which combined with glass fibres form a new plastic which has wide potential use in furniture and home furnishings, luggage and automobile bodies.

Although the new plant is the first to make vinyltoluene in production quantities, Dow chemists have had plenty of time to become acquainted with its habits and potentialities. For five years the company's chemists and engineers have been making vinyltoluene and investigating its possible uses. Beginning with glass columns in the laboratory, the scale of operations gradually expanded through the pilot plant stage. In laboratory and semi-production units most of the kinks were ironed out of the process and the know-how established for making vinyltoluene on a large scale.

Since vinyltoluene is similar to styrene its manufacture is likewise similar and essentially the vinyltoluene plant is a styrene plant. Some modifications were necessary for differences in the chemicals.

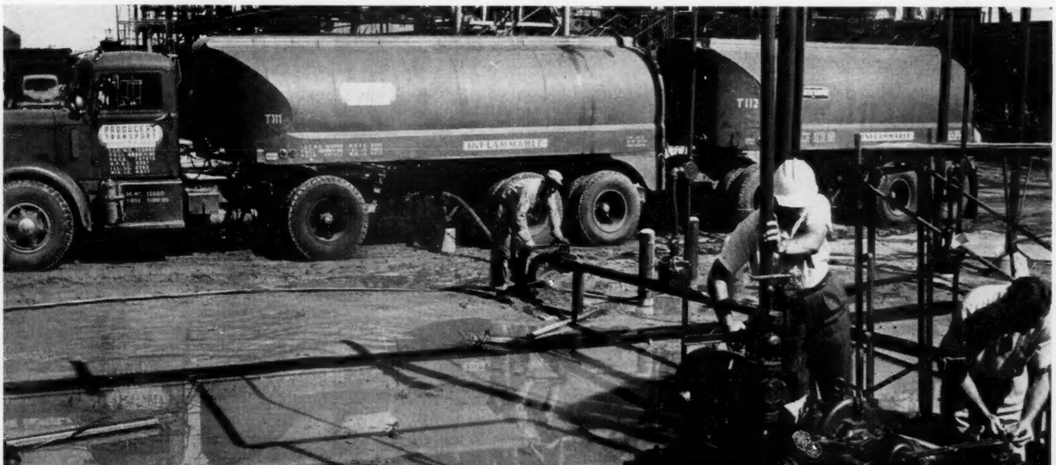
For safety, the plant units are the "outdoor" type, with no place for vapors to collect. Practically all the operating is done by remote control, from a central control room where no chemicals are ever present. Storage tanks are located well away from the production units, and are surrounded by earthen dikes capable of preventing the escape of the contents of a tank in case of a leak.



If research studies prove correct, synthetic rubber tires using vinyltoluene will roll from this plant.

Because of the heavy demand for toluene in making explosives, several plants capable of turning out great quantities of this chemical from petroleum were built in the U. S. A. during World War II. This capacity will be available for peacetime uses of toluene, including the making of vinyltoluene. The availability of toluene as a raw material source for the new monomer is significant since the supply of benzene, from which styrene is made, has been critical from time to time.

Outside of the substitution of toluene for benzene as a starting material, basic steps in the manufacture of vinyltoluene are identical to that of styrene. Toluene is reacted with ethylene, another petroleum product, and the resulting material, ethyltoluene is "cracked." Cracking involves heating under controlled conditions to remove hydrogen, making vinyltoluene. This chemical then is purified by distillation. ★



Above, toluene is pumped from tank trucks into the new storage tanks, ready for vinyltoluene production.

Quotes

Points from current papers and speeches

INELASTIC BEHAVIOR of ductile members under dead loading is the subject of University of Illinois Bulletin No. 426, by **M. E. Clarke, H. T. Corten** and **O. M. Sidebottom.**

Since the turn of the century, considerable work of both a theoretical and an experimental nature has been undertaken to determine the inelastic behavior of load-carrying members in which the stress distribution is nonuniform. This interest has risen due to the fact that the maximum utilizable load on the member may be appreciably increased by allowing only a small amount of inelastic deformation to occur in the member. A large portion of this work has been confined to the inelastic bending of beams. The early experimental work was performed on mild steel beams because of the prevalence of applications and the ease of theoretical treatment. However, the results obtained by several of these investigators led to the conclusion that the yield point of the mild steel itself was raised in the presence of a nonuniform distribution of stress. Three investigators, **G. Cook, F. Nakanishi** and **J. L. M. Morrison,** were speaking of the upper yield point in drawing their conclusions; however they found that the lower yield point in the beam tests agreed closely with that found from standard tension tests. Other invesigators indicate that in beams in which the upper yield point is eliminated, the lower yield point is not raised; rather, the increase in load-carrying capacity is altogether due to beneficial redistribution of stress accompanying the yielding in the member.

Similar conclusion were substantiated by several more investigators who worked with materials like aluminum, magnesium and annealed high carbon steel which exhibited strain-hardening characteristics throughout the inelastic range. In these recent investigations, the experimentally determined moment-deformation relations were found to agree closely with those obtained by a theoretical analysis based on the stress-strain relation found from the simple tension test.

In all the investigations mentioned above, the results were obtained from tests which were of relatviely short duration. Even though inelastic deformation is known to be time dependent, most of the tests were conducted in conventional testing machines in which it was constantly necessary to adjust the head of the testing machine when loading the inelastic range. The final deformation readings at each load were taken in all the investigations before a condition of equilibrium between time and deformation had been reached. The results, therefore, depend upon the duration of the test. In actual service, the loads are not, in general, applied for short periods of time but rather are maintained at constant magnitude for extended periods of time.

In the present investigation service conditions were simulated by applying dead loads to the members for extended periods. To analyze the data, a comparison was made of the theoretical and experimental relations between a load parameter and deformation parameter in which each test load was maintained at a constant value until equilibrium was reached. The theoretical relations which were used in this comparison did not include time as a variable and the differences observed were attributed to time effects. The purpose of this investigation then was to present the experimental data for conventional short-time and for long-time dead-load tests of various ductile members, to compare theoretical and experimental results, and to attempt to explain differences observed between the two types of test.

• • •

IN A BULLETIN by Johns-Manville are given details of **asbestos textiles** with which today, countless products are being made safer, better and at lower cost. These versatile materials enter into practically all phases of our everyday living.

They serve in friction facings and linings for industrial equipment, insulations for electrical wires and cables, padding for laundry presses, beltings for conveying hot materials, covering for insulation mattresses and high temperature piping, diaphrames used in electrolytic processes, fire-fighting emergency blankets and protective clothing, fire protective boots on airplane parts, tin and galvanizing wipers, vacuum bags in cleaning and conveyor systems, mailbags, expansion joints, packings and gaskets, filters and many other products.

New uses and applications are being discovered and developed nearly every day. The resistance of asbestos to many chemicals and acids, its incombustibility and its flexibility and fineness of fibre are earning for these textiles an ever-widening field of usefulness in product design.

The brochure covers asbestos lap, roving, yarn, cloth, tubing, cord, wick, rope and tape. There is a page or more on each type of asbestos textile and the information includes photographs, drawings and essential data in tabular form.

This manual is prepared primarily for designers and purchasing agents in companies which use asbestos textiles in their products. The manual can also be of value to those who buy or specify for uses where high ambient and operating temperatures prevail, as in iron and steel mills, foundries, glass works, radio and television tube manufacturing plants, the automotive and aviation industries and certain other types of fabricators.

• • •

NEW DEVELOPMENTS in automobiles seem to appear in cycles, stated **Forest R. McFarland** in an SAE paper: The New Packard Torsion Level Suspension. In the early thirties, helical gear transmissions and synchronizers were introduced. In the early and middle thirties, independent suspensions appeared on American automobiles setting a new standard of riding comfort and control of vehicles. From 1939 to 1953, we have seen introductions of automatic transmissions by all makes of American cars.

The second chapter of continued innovations is following from 1953 to the present time and apparently due to continue for some time into the future. We are all familiar with the engine programs resulting in the change from straight eights to V-8s which has swept the industry.

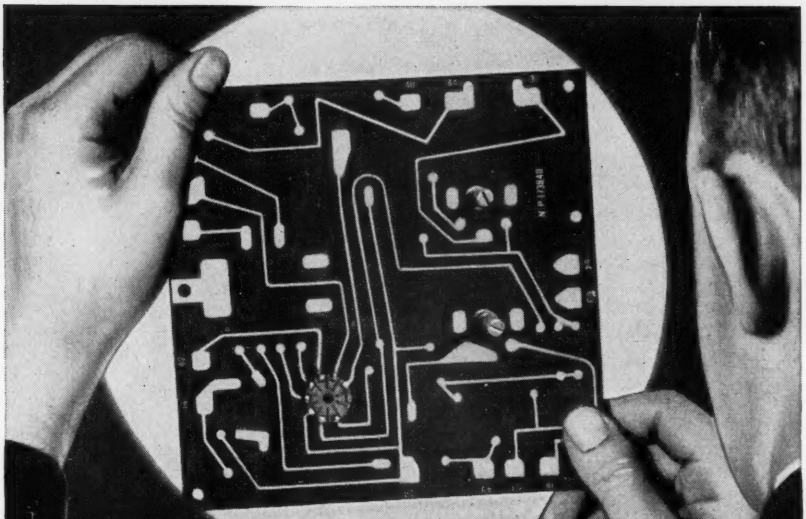
We have now reached the year 1955 with no change in principle for 20 years, in the over-all design of suspensions on American cars. It would seem that a change in suspensions is overdue.

Since 1935, Packard Engineering has analyzed many ideas in the search for something new in suspensions that would be a definite step forward in improving the ride of our cars. We hoped to gain an improvement that would be apparent to a customer before he had driven the car more than a couple of blocks.

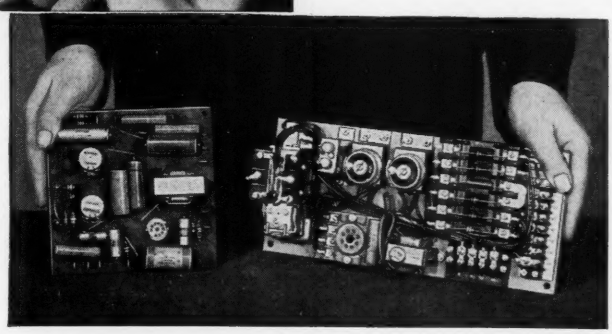
It has been generally known in the industry that a better boulevard ride could be obtained by lowering spring rates, but that stability on the road suffered. Car suspensions have been compromised to give a certain amount of the former and a certain amount of the latter. Any suspensions that would improve both boulevard ride and road stability would be a definite step forward.

Packard has had patent coverage on torsion bars connecting front and rear wheel suspensions since the thirties.

C.G.E. Announces New Low-price Thy-Mo-Trol* Drive with Printed Control Circuit...



Shown here is the "brain" of the new general purpose G-E Thy-Mo-Trol Drives. Here an electrical diagram, or electrical "track", is printed on the back of a sturdy plastic board. This "track" consists of solder-covered copper strips which connect all circuit components without the use of wiring.



Here is ample evidence of the simplicity and reduced size made possible by the new G-E printed control circuit system, left. At the right is the conventional type. Note its larger size and complexity.

NOW! GET RELIABLE, SMOOTH, ADJUSTABLE SPEED FOR MACHINE TOOLS IN A SIMPLIFIED LOW-PRICED DESIGN!

By adapting printed or "wireless" circuits to a completely new line of G-E Thy-Mo-Trol Drives, C.G.E. offers industry electronic adjustable speed drives at up to 20% reduction in cost.

These drives consist of an electronic control panel, a DC motor, and a push-button station. The big price difference is made possible by the use of printed circuits in the control panel. Designed for quality performance, reliability and easy maintenance, these G-E Thy-Mo-Trol drives are available in two ratings: ¾ to 1 hp and 1½ to 3 hp. They feature reductions in weight, size, circuit complexity, wiring, and maintenance and installation costs. They supply constant torque over the entire speed range, which is 8 to 1, with higher ranges possible for special applications.

For further information on these outstanding new low-cost drives, contact your nearest C-G-E office or write to: Apparatus Department, Canadian General Electric Co. Ltd., 212 King St. West, Toronto, Ont.

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A BETTER LOOKING, 30% shorter, 50% lighter oil burner motor has been developed by the **Fractional Horsepower Motors Section** of the **Canadian General Electric Company.**

An outstanding feature of the new motor, which has not changed fundamentally in design, is the CSA approved arrangement of connecting the motor and the ignition transformer by a flexible tough-jacketed cord. This innovation eliminates the use of two BX fittings and a length of armored cable. (200)

A New G. E. Burner Motor

• • •

A NEW INSPECTION tool, developed after three years of research and study by the **Babcock and Wilcox Co.,** will enable small foundries and plants to invest in high energy radiographic equipment where the cost of high voltage equipment is often prohibitive.

Known as the "Isoscope" (derived from the words isotope and scope), the machine can see through thicknesses of steel up to seven inches. Requiring only one third the exposure time of a million volt X-ray machine, the new tool uses radioactive cobalt 60.

For its development, the largest assignment of radioactive cobalt 60 ever authorized to industry was assigned to the company by the Oak Ridge National (Atomic) Laboratory on October 11, 1954. The material was loaded into a special dual-purpose spherical lead container especially designed to handle the radioactive machine upon arrival at its destination.

A steel jacket, with a cylindrical rotor built into it, encases the lead sphere of the Isoscope. When this rotor is revolved 180 deg, the radioactive source can be brought into the safe position to a point in line with the coned opening of the steel jacket. This alignment then allows a beam of radiation to escape. The arrangement also makes it possible to turn the machine on and off.

A modified electric platform lift truck has a lead cab built on the back, which provides protection for the operator and contains the controls. These consist of a timer, an on and off switch and a green, amber and red light system, designed to inform the operator of the radioactive source at all times.

In operation, the lead ball containing the cobalt 60 is stacked in small discs like coins in a changer, to make up the total charge of 1,008 curies of cobalt 60. The radiation is taken from the top of the stack so that the focal spot compares favorably with existing high voltage x-ray equipment.

Assembled, the unit can be raised or lowered through 8 ft. It can be rotated vertically through 210 deg and horizontally through 360 deg.

Offering low initial cost over high voltage x-ray equipment, use of the Isoscope means a reduction in the amount of shielding necessary for secondary radiation. Other features include known maintenance and operating costs, which cannot be accurately made with conventional x-ray equipment, and greater mobility. The Isoscope can be operated manually so that a mechanical breakdown need not interfere with the examination. Apart from these advantages, the controls are so simple that a highly trained technician is unnecessary. (201)

ALL ELECTRONICALLY operated radio and navigation aids and guided weapon equipment are due for even greater efficiency in their cooling systems with the development of a range of miniature axle-flow fans.

Now in production by **A. K. Fans** of the U. K. the new range starts with a 1½ in. diameter fan and includes fans up to 3¾ in. diameter. The company also makes fans from 4 in. up to 72 in. diameter.

The demand for greater volume with less pressure (or vice versa) is met as required since there are alternative rotors of the same diameter for practically every size fan.

"Airmax" fans made by A. K. have been used for cooling transmitters and receiving cabinets, guided weapon equipment, high altitude aircraft, radar, marine radar, and all navigational aids.

British Admiralty requirements are covered with one fan of 45 in. diameter which is in service in many types of naval craft. Air Sea Rescue Launches use a 4 in. fan. (202)

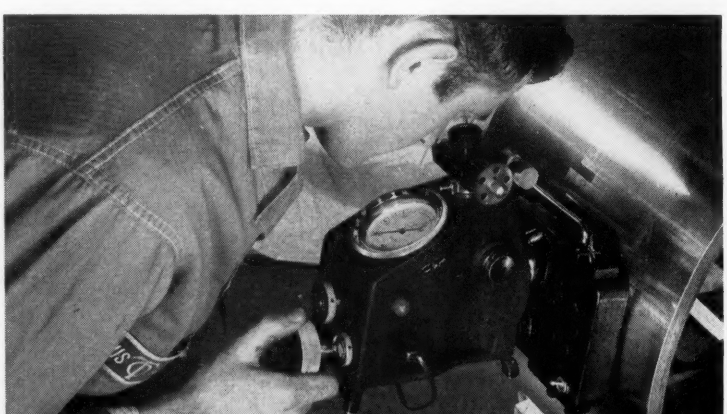
• • •

A METAL HARDNESS tester so light and compact that it can easily be transported and fastened directly to parts of any size in the laboratory or on the assembly line has been developed by the **Tinius Olsen Testing Machine Company.** It can be used for testing ferrous as well as non-ferrous metals.

The Mark VI Pentrascope, as it is called, employs the most accurate method of hardness testing known, according to its manufacturers.

Specimens ranging from metal strips 0.002 in. thick to cylinders over eight ft. in diameter can be tested through the use of a variety of clamps, including chain, magnetic and C clamps.

The tester has shown extreme accuracy in the 16 to 800/1,000 range (from softer than O on the Rockwell B scale to 64/69 Rockwell C). (203)



Tinius Olsen Portable Tester

design is so much more than styling

As the stylists play with "prettyness" industrial designers strive for products best suited to those who use them

Of all the problems that Canadian industry now faces, probably none is so important as the need for more, and better, original design work.

For this reason, DESIGN ENGINEERING **plans to carry feature articles from time to time which put the point of view of designers before engineers and management in industry. The magazine believes that a better understanding of the value of industrial design is essential if Canada is ever to move upward among the world's industrial nations. Here is the first feature.**

By L. G. McINTOSH, P.Eng.
CONSULTING ENGINEER, DESIGNER

SOME ENGINEERS if asked to describe the industrial designer's activities would say that he is the artist who proposes new designs that he feels will sell because of his great knowledge of the "buying public." His main purpose is to increase sales; and this may be accomplished by any means he can think of—such as adding a fin, a dash of chrome, or even a false air scoop, to give the design more "eye-appeal." In a word he is the "stylist."

This is not "industrial design!" The stylist first makes designing difficult for the design engineer and tooling difficult for the tool engineer. And in any case, increasing sales is not the main purpose—although it should be a result. The purpose is to better performance and function, to lower cost by simplification, and to improve appearance; appearance cannot successfully be separated from other considerations. This is where the "pure stylist" makes his inexcusable error.

The visual satisfaction felt in the use of a device should be directly related to the user's relative position, the "feel" of controls, knobs, or handles, the legibility of instruments, the harmonious interrelation of all component parts and the satisfactory performance of their functions during operation, and lastly the materials and processes employed in manufacture inasmuch as they suggest the logical way to fabricate component parts. In brief, the entire design must be integrated. Only then will appearance bear its proper relationship to other aspects of design.

The best way I can illustrate this relationship between appearance and other aspects of a product's design is to consider some examples from my own experience.

The operator's platform (see picture) from which the driver controls the self-propelled Massey-Harris harvesting combine, will serve to emphasize some of the points I mention. Look at the operator's relative position, the "feel" of controls, and the legibility of instruments. Compare the result here with the platform on the previous machine. Notice particularly the position of instruments, the less convenient hand lever for speed control, and the general lack of harmony in the layout of hand railings, steering column and control box. In redesigning this platform we tried to give due thought to all of these factors and relate them to the over-all visual effect.

The second example, chosen also from experience with the Massey-Harris-Ferguson organization, will point up the important relationship between manufacturing technique and product design. Another picture shows a cream separator as it existed before redesign. One of the main reasons for establishing a

ABOUT THE AUTHOR

Few Canadian engineers are also trained designers. Lawrie G. McIntosh, author of this article is one. He graduated as an engineer first, from Toronto University, then attended the Institute of Design in Chicago—and found the course what he describes as a "psychological shock." He reports that, "after the disciplines of applied science it seemed a waste of time to be asked to doodle and bend wire." Once he nearly quit, then decided to struggle on. Since then he has won numerous product awards both in Canada and abroad.

Pictures opposite show that a thread of simplicity links most good designs ▶

The designer is as much concerned with construction as with looks

redesign program was that the large cast iron support for the "tinware" and supply tank and the cast base were costing too much for finishing before final painting. To obtain a smooth finish on an iron casting requires a lot of time and effort.

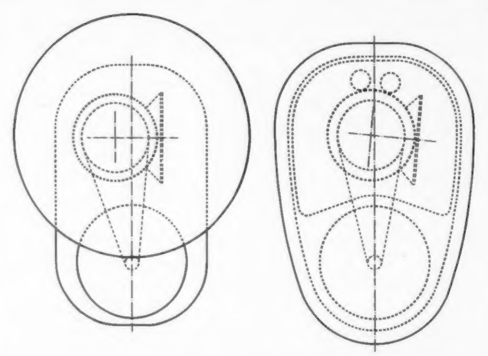
In the new separator the cast iron is reduced to a simple internal bearing housing to maintain necessarily close tolerances in alignment. This, of course, requires no special finishing. The remainder of the structure is entirely sheet metal in stamped or bent shapes, including the legs. The finishing costs saved in changing to sheet steel were sufficient to pay a good portion of the cost of changing from tinned carbon steel to solid stainless in "tinware" and supply tank. The resulting appearance (see picture) of the new separator is largely dictated by this change in manufacturing technique.

Also affecting the appearance of the new separator to an important degree was the consideration given to the logical, rather than arbitrary, interrelation of internal and external parts. A diagram shown here gives a comparison of the plans of the two separators.

Simplicity is extremely important to both visual and functional satisfaction. The smooth flow of line from front to back and top to bottom in the steam iron, made by Steam Electric Products Ltd., provides not only what we considered pleasing appearance but also good streamlining. I hesitate to use that word. But in this case it has meaning. It refers to the ability of the iron to slip into sleeves and pockets without obstruction and to move forward and backward and around buttons and frills with equal ease. It was designed for the work it has to do.

We know of the need for a comprehensive approach to product design; so consider the question of why there are so many examples of badly conceived design in evidence today, and what might be done about it. The corruption of product design in many instances to the level of styling, exemplified in the extreme by the vulgar, absurd and expensive ornamentation on the typical American automobile, has two main causes. First is the obsolescence factor which, rightly or wrongly, has become so important to the whole North American economy. Second is the apparent complacency of the engineer!

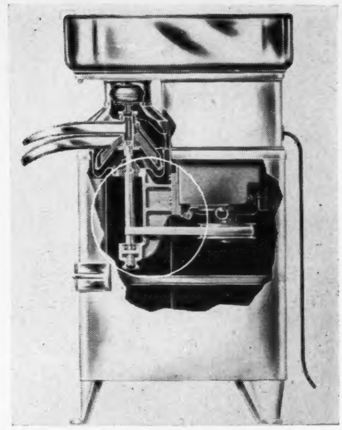
The first cause is complicated. Briefly, the economist's explanation of the "obsolescence philosophy" is that by designing for quick obsolescence the manufacturer causes discontent on the part of the consumer and so induces him to buy a new product to replace the old. The increased sales bring increased production which in turn lowers costs and makes available more products and more employment for more people; the economy is stimulated and the standard of living is raised. In strictly economic terms this sounds rosy—but it seems to me that "standard of living" involves more than economics. Does it not involve **(Continued on page 58)**



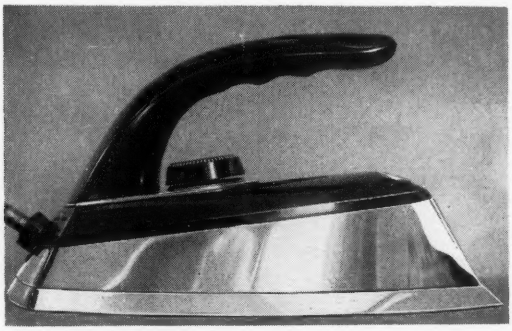
Integration in design

Cream separators, old (left) and new. Note how unrelated shapes were brought together to make a disciplined, pleasing design form.

A well designed Gurney range. Controls have been placed on the cool side for safety, where they echo the pattern of heaters. Recessed handles are clean and damage-proof.

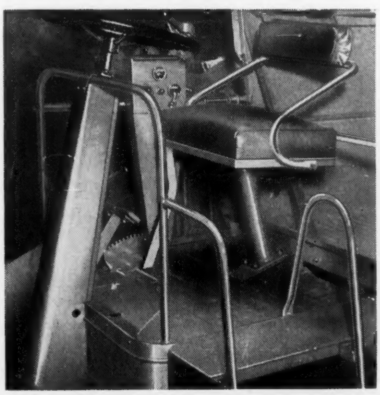


Cream separator plans (opposite page) show improved lines. But besides this, production was simplified by the elimination of special finishings on castings. Compare the old model (left) with the new (centre). Two big iron castings were replaced by sheet steel and a small cast bearing support (circled on right).



This steam and dry iron won an NIDC award. It is light, easy to hold and, despite its internal complexity, is simple in form. Simplicity of form and structure also brought an award to shoe-store chairs (above).

A good designer achieves same high standards whatever product he tackles



Better control for combine operators

Improving a combine. Note (at left) instruments and control grips are not ideally designed or placed, a toothed quadrant is exposed and handrails are untidy. The re-designed combine has put these imperfections right. Controls and instruments have been grouped and well-placed (centre) and rails simplified (right).

Industrial Design

(Continued from page 57)

"standard of design"? Must we always wonder when we buy a product how much we are paying for inherent quality of design and how much for surface glitter? The increased production resulting from obsolescence is supposed to reduce costs but what about the toolage charge for a redesigned and relocated chunk of chrome plated trim* and the cost of the piece itself? These costs will certainly moderate any overall rise in the living standard on economic grounds alone—and we still have to live with the resulting misconceived and malformed masterpieces!

I do not think that any single group, such as manufacturers, retailers or consumers, can be blamed for this idea of change for the sake of change and the resulting flood of badly designed products. Above all let us not blame the poor consumer. He can be swayed by any healthy merchandising program regardless of design standard. In any event the idea is here to stay and it is up to us to make the best of it. If a change is required let us do our utmost to make it an improvement and not merely a change. It is a further challenge to the designer's resourcefulness in introducing sound ideas.

Then there is this second cause, the complacency of the engineer. The average engineer will likely say, "Industrial Design? What has styling to do with engineering?" It has a great deal to do with engineering. The design engineer should be very much concerned —not with styling but with **good** product

(Continued on page 62)

*See this month's editorial page.

Man-Made Moon Is Astro Research Tool

TO THE AVERAGE pleasure seeker, northern trout fishing and Marilyn Bell's Channel swim took precedence over Washington's holiday-week end announcement that the U. S. will launch a man-made satellite in 1957-8.

Few knew that much of the information the moon-makers are using came from Canada. And among those who seemed to regard it as an all-American achievement were most Canadian newspapermen; little space was spared for the story of this country's contribution.

Yet Canadian scientists have done much to help the project on its way. DESIGN ENGINEERING spoke to one of them—Dr. G. N. Patterson, Director of the Institute of Aerophysics at Toronto University. He has been at work on the project for four productive years. "The U. S.," he said, "finds it has to turn to us for advanced hypersonic studies. Our discoveries are being used in the design of the satellite."

Dr. Patterson, a tall, robust former Westerner is undoubtedly Canada's foremost authority on the subject. Aerophysics has been his life's work since graduating in Engineering Physics from Alberta University in 1931.

Appointed a Professor of Aerodynamics at Toronto in 1947, he now guides the work of graduate students in hypersonic flight studies at very high altitudes.

"Construction of a space satellite is entirely possible," he confirms. "The Canadian Defense Board has asked us to provide information which no other institution in the U. K. or the United States can supply."

"We have been studying drag and transfer of heat in very high altitude hypersonic flight. We are looking for formulas that make the prototype feasible."

Getting the speed to push the satellite into space is not the problem. Multistage rockets will do that. The chief hurdle is production of metals that will withstand the terriffic heat induced by hypersonic flight.

At the Institute, hypersonic speeds up to Mach 25 have been under study from ground level to the fringes of outer space.

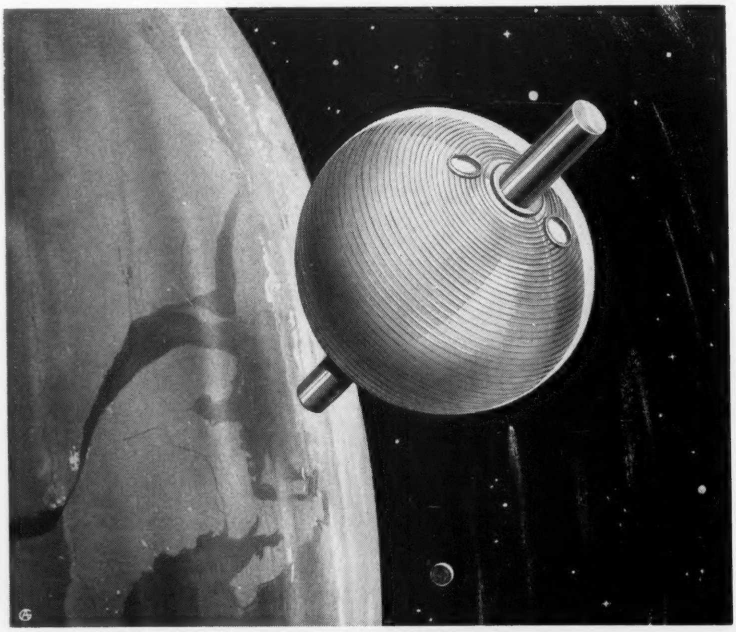
Moving his hand rapidly, he said the satellite will travel over 26,000 mph when it reaches what is known as escape velocity.

"Flying at twice the speed of sound (Mach 2) even, the surface temperature exceeds 450 C" he explained. "The satellite will have to go up at least 125 miles before it gets out of the heat barrier."

Asked how the problem of heat would be overcome, he replied: "At present the only way we can prevent the satellite from melting to end as a failure is to construct it of metal so thick that allowance will be made for this unavoidable melting."

Dr. Patterson does not believe Canada's efforts should be forgotten. "Our scientists here," he said, "are providing design engineers with the information to make design of the prototype possible."

Cost of the project will be over $10,000,000. And someday in the next two years when it is launched, Canadians can rest assured that work by Dr. Patterson and his staff helped immeasurably in bringing space travel closer. ★



Satellite spins 300 miles up over North America

File

New booklets and books written for you

PUBLICATION OF Bulletin 243, describing the **Symons V-Screen,** is announced by **Nordberg Manufacturing Company.** This screen is specifically designed for fine screening, for sizing, dewatering, dedusting, cleaning and washing. It is unique in its construction and operating characteristics, the only screen that does not depend on gravity alone for its screening action.

The bulletin tells how an entirely new screening action multiplies its screening effect by combining centrifugal and gravitational forces for high capacity and sharp, single cut, wet or dry separations. Details of construction and operation are given. Dimensions of the screen and three types of collection hopper bases are shown. Operational data from installations show successful application in sand and gravel, stone, coal, ore, slag, non-metallic minerals, chemical, grain and food product plants.

It differs from conventional screens because it uses controlled diffused feed and vertical flow of material within a screening drum. Relatively low rotary speed and high speed gyratory action produce a separating force that more than doubles the capacity of each square foot of screen surface with an efficiency up to 98% and separations as small as 100 mesh. The screen is smooth and quiet running, requiring no special foundation or anti-vibration devices. (204)

• • •

DATA IS GIVEN, in a brochure for the **Celanese Corporation** of America, of **Fortisan-36,** the registered trademark for their highly oriented, regenerated cellulose (rayon). It differs from regular grades in that it has higher strength and is made by an entirely new process which produces yarns with a high degree of uniformity. It is especially suitable for the production of the heavy deniers required in industrial applications.

For the present, Fortisan-36 will be manufactured commercially only as a continuous filament yarn in 800 denier/800 filament. 1,600 denier/1,600 filament and other denier yarns and two have been made but commercial production of these will take place later.

The material has exceptional strength, unusually high resistance to stretching under tension and good dimensional stability.

The data listed under physical properties gives values which were obtained on samples of yarns produced on pilot plant equipment. They are not shipping specifications and should be used only as a general guide. (205)

• • •

IN BULLETIN 6000-A, published by **Vickers Electric Division,** the magneclutch and magnechoke are covered. The magnetic-particle clutch provides a flexible, easily regulated torque control and power transmission without chatter, grab or wear. This principle does away with the use of gears, sprockets, linings, spring, air and fluid pressures. Other mechanical and centrifugal clutching devices are also unnecessary. Using this method there is no wearing away of the torque transmitting surfaces even in service where there is severe slippage.

Without adjustment, performance characteristics stay the same throughout a long service life, due to the elimination of mechanical wear.

Working on the same principle, the magnechoke features a magnetic-particle bond between two surfaces. If one surface is rotating, and the other is stationary, the magnetic-particle bond exerts a braking force on the rotating surface. (206)

• • •

A PUBLICATION for the **St. Joseph Lead Co.** tells the story of **Diecasting** as a method of production and explains the role of zinc as a cast metal for die-casting alloys.

After showing how the Bunker Hill Zinc is obtained, an explanation is given for the die-casting method and illustrations of its application to the electrical appliance industry, and for general industrial equipment. (207)

• • •

A NEW 56-page, 3-color ilustrated catalogue (No. 5001A), describing the complete Vickers line of oil hydraulic pumps, controls and accessories for general industrial application, is now available from **Vickers Incorporated.**

It includes engineering, design and application information about pumps, pressure controls, volume controls, directional controls, control assemblies, hydraulic motors, transmissions, cylinders and hydraulic accessories. In each category there is a description of the various units that make up that group. The section on pressure controls, for example, covers relief valves, sequence valves, unloading valves, counterbalance valves, pressure reducing valves and pressure switches.

Each unit is given in detail, with a photograph, cutaway view and typical circuit drawing where required. The operation, typical applications, and data relating to the selection, purchase and application of hydraulic equipment is also given. Tables showing model designations, ratings and capacities, as well as typical performance curves, are included for many of the components discussed in the new catalogue. (208)

Book Department

This age of the phonograph, radio and TV has brought into being a new type of engineer, one who has to be well versed in the general aspects of music.

A new book, Musical Engineering, looks through the eyes of the engineer at such inter-related subjects as speech, music, musical instruments, acoustics, sound reproduction and hearing. It makes fascinating reading!

After describing the general behaviour of sound waves, including decibels and the Doppler effect, the reader is reminded of what he once had to put up with in a section on musical terminology, (clefs and key signatures) and much-hated scales, with particular reference to the equal-tempered scale, which has to be used on all instruments for practical reasons.

Next comes a summary for the engineer of resonators and radiators and the important electrical analogies denoting vibrating systems. This includes clamped bars, stretched membranes, circular plates and horns. All this information is useful to the vibration engineer.

A chapter on musical instruments is rather specialized, but it deals with electrical instruments, including the ubiquitous organ and guitar.

However, why include the sarrusophone? It is a dead duck belonging only in a museum.

It is rather strange too that more was not said of the principle of action of the brass-wind by showing, for example, how valves increase the scope of a trumpet, or why the clarinet overblows a twelfth and not an octave, like the saxophone.

There is a chapter of particular interest to the architectural engineer, dealing with theatre, studio, and room acoustics, and another section on sound reproducing systems.

Apart from its usefulness, the book (by Harry F. Olson) is so interesting that the engineer should keep it handy for his leisure moments. Price: $8.50.

Industrial Design

(Continued from page 58)

design. Too often the engineer considers appearance as being something separate and foreign to his domain. I hope that by example I have shown this to be wrong. It is partly because of this misconception that the field of design has been in places dominated by the "industrial stylist." He is nurtured by the engineer who refuses to co-operate and provide the information so essential to a good design approach, such as the limitations and necessary requirements of a proposed new design. No wonder that same engineer often finds himself confronted later with a monstrous proposal that must be either rejected completely or so modified and adapted for production that the designer's original thought is completely lost, for better or for worse. Co-operation is without doubt the most important constituent of any design program.

Try the training

If only more engineers who find themselves disturbed by the way in which some designs are executed (I might say butchered) by the unqualified designer, would avail themselves of postgraduate training in basic aesthetic principles (a flair for art is hardly enough), and either co-operate more fully or get into the field themselves, I am sure the results would be gratifying.

The birth of industrial design as a profession must be credited chiefly to the architect. When the contemporary architectural forms began to emerge, the architects found themselves confronted with crystal chandeliers, overstuffed furniture, and hardware fittings that were highly ornamental and not at all in keeping with the functional approach. They resorted to designing their own products for limited production to satisfy the need. Many architects have since branched out into design for quantity production and some have done excellent work. But, after all, are not the architects and their colleagues working under a handicap with no specific training of production experience behind them?

Let the engineer pitch in to take his share of the responsibility. ★

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Miniature Turbines

(Continued from page 33)

more versatile prime mover. In addition, a gas turbine can be adapted to furnish all or part of its power in the form of compressed air. Once the major components — compressor, combustor and turbine—are working in an efficient relationship backed up by sound construction and fool-proof controls, the unit is ready for any one of a number of jobs. It will only be necessary to make minor modifications to gearbox, controls or channeling of the air. In most cases these can be tooled quickly without extensive new development programs starting from scratch.

The basic requirements of the Solar model T-45 unit was for a prime mover to drive a centrifugal water pump of the same rating as the pump used on the Navy's original Type P-500 portable waterpump set. This rating, with sea water, is: flow, 500 gpm; discharge pressure, 100 psig; suction lift, 16 ft.

With a power plant operating at the normal high speed of a gas turbine, it would appear logical to design a high speed pump. It was found, however, that this suction and flow rate could not be achieved without cavitation at a pump speed much above 4,500 rpm, which is the speed of the original pump. Therefore the original pump, with some minor modifications, was used, and the power plant was designed to suit it.

Although the standard ambient temperature for navy gas turbines is 80 deg. F, it was agreed to base design calculations on an ambient temperature of 120 deg. F, to be sure of rated power under all operating conditions. At the rated flow conditions above, the pump requires an input of 47 hp on the driven shaft. Hand starting was required, and diesel fuel (navy specification No. 7-0-2e) was specified. A waterproof ignition system of maximum simplicity, that would operate reliably without battery or external power, was called for.

A single-stage, centrifugal compressor was chosen because of the limitations on compressor pressure ratio imposed by the hand-starting requirement. The influence of size effects, including those of Reynolds number and leakage, and the necessity for holding weight to a minimum, also influenced this choice. Similar factors, as well as the need for simplicity and low manufacturing costs, dictated the use of a radial inflow turbine.

At first it appeared desirable to construct the compressor and turbine rotors as a single integral part, with compressor and turbine blades situated on opposite sides of a common disc. However, consideration of all factors resulted in a decision to use separate rotors.

The two rotors are separated by approximately 0.5 in. measured at the hub. They are mounted on the shaft adjacent to the roller bearing in a cantilever arrangement. At the rated speed of 40,300 rpm, the peripheral speeds of the 6.97 in. compressor rotor and 7.42 in. turbine rotor are 1,220 to 1,300 fps respectively.

The modified elbow-type combustion chamber was selected chiefly to conserve space.

Gearing is Simple

For maximum simplicity, the reduction of turbine speed to the pump speed requirement was accomplished by a single spiral-bevel gear and pinion, providing right-angle drive.

The envelope dimensions of the set are: length, 26⅞ in.; height 23½ in.; width 23⅞ in. Other details are listed (see table).

The centrifugal type compressor rotor is machined from a 25ST aluminum alloy forging. Blade leading edges are shaped to serve as an inducer. Both the turbine and compressor rotors are mounted back-to-back, with a seal plate between, on a common shaft which extends through the centre of the compressor scroll and air inlet casing. A nine-blade, stainless steel compressor diffuser is bolted to the scroll. Compressor air is discharged through a bellows-type expansion joint to the combustor inlet. A butterfly valve in the scroll outlet provides a means of creating a low velocity area in the combustor during starting which is a useful ignition aid.

Between the compressor scroll outlet and the turbine scroll inlet is a modified elbow-type combustion chamber, formed from Type 321 stainless steel in order to conserve critical materials. It differs from the normal gas turbine combustor in that there is no liner, but only a short, flared, dome-shaped flameholder set in the turbine scroll opening. An 8.3 gph, 80-deg. spray angle Monarch nozzle admits fuel to the airstream through the flared skirt of the dome. An aircraft spark plug, set just below the skirt, initiates combustion, which is held inside the dome or flameholder.

The radial inflow turbine rotor, mounted on the shaft with the compressor rotor, has blades shaped to form an exducer in the same manner that the compressor blades are shaped to form an inducer. The rotor is encircled by the turbine scroll and nozzle, and a short tailpipe is centred behind the rotor hub. No exhaust diffuser is used, but a means is provided for cooling the exhaust gases. Hot gases pass from the combustor into the turbine scroll and are directed angularly inward by the turbine nozzle blade contour. Then they whirl farther inward through the rotor and turn to exhaust axially through the tailpipe.

A Hastelloy B forging was chosen for the turbine rotor. This part was machined, on the prototype model, but future rotors will be investment cast in order to hold down manufacturing costs.

There are some disadvantages that come with the gas turbine, but not many. This newer method of providing power is winning the approval of more and more design engineers and seems all set to go on winning friends in the future. ★

Oops! It was loaded.


A
B
C
D

Stress Lofting

(Continued from page 40)

the main central spar, while the root attachment points are at the top booms of a short front spar and a continuous rear spar. So, two diffusion problems are introduced, as the concentrated loads at the root spread over the cross-section on their way outboard, and then collect again into a single concentrated load at the strut attachment point. Somewhere between the root and the attachment point it is assumed that there exists a region sufficiently remote from the two extremes for diffusion effects from either to be of no consequence. This region, then, may be examined by the normal theory of bending, which will yield flange loads as before. These may now be faired to the known end conditions at the root and strut, where all flanges except those which form points of attachment will have zero load.

Stresses — not loads

The difference between this example and the simplified case is merely that the effect of varying flange area must be considered by working with flange stresses rather than with flange loads when drawing section profiles. This is because the requirement of consistent strain demands that adjacent flanges deform regularly. The stress in the flanges at any particular section must therefore change across the section according to a curve that is continuous. The diffusion "surface," then, must be faired so that buttock lines of load are reconciled with section profiles of stress, introducing merely the added labor of dividing flange load by flange area. During this fairing process, the effect of the web thicknesses may be considered approximately, by biasing the load transfer to adjacent flanges a little more heavily if the local web material is stiffer than normal.

Again, after fairing, equilibrium at intermediate sections may be examined by checking that:

$$\Sigma p_r = F + R \qquad (1)$$

$$\Sigma p_r z = FzR + RzR \qquad \text{(Pic. 3)} \quad (2)$$

$$\Sigma p_r x = FxR - RxR \qquad (3)$$

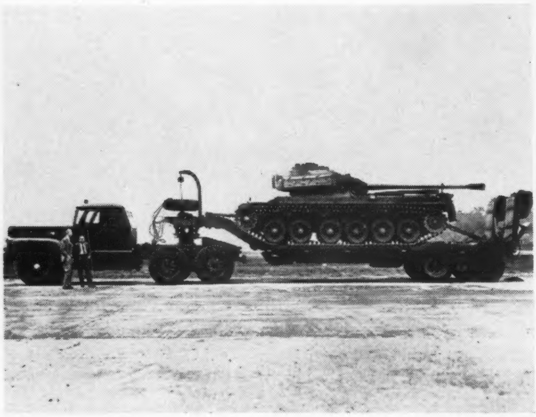
As before, the exact nature of the out-of-balance, shown by these three expressions after the first cycle, governs the refinements needed in the second cycle, so that the process is rapidly convergent.

After sufficient refinement to the faired "surface," the validity of the diffusion pattern may be examined further by finding the pattern of shear flow in the webs. Examination of what, in the case considered, is a 3-cell box structure, by any

(Continued on page 76)

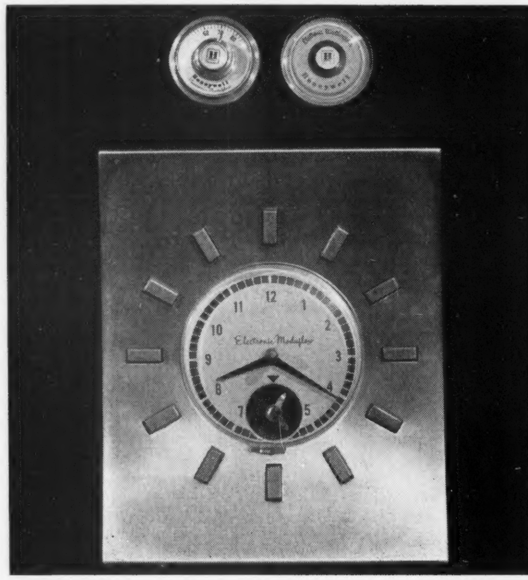
Design news in pictures

Some modern designs making news today



Rigorous tests by U. K. Ministry of Supply of David Brown gear boxes in monstrous tank transports which can carry largest British tank is under way. Twelve forward speeds are possible and despite the weight of the vehicle and size of box, the change is easy.

XF2Y-1 "Sea Dart" U. S. Navy delta wing jet fighter makes high-speed taxi run in hydrodynamic research tests. Fitted with single ski instead of twin skis and powered by twin Westinghouse J-46 engines, it is first jet seaplane ever built to exceed sound.



Above, color styling and engineering improvements are featured in all three units of new Electronic Moduflow home temperature controls by Minneapolis-Honeywell. Clock contains automatic night setback. Upper left, new thermostat, weathercaster on right.

Reel type intercom system by Wheeler Insulated Wire has powered handset which eliminates power from the outside. Hand wound reel holds 250 ft. cable rolled by crank. Other features include specially designed cord retaining unit and voice cartridge in handset.

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- Following each announcement on the New Products and File pages are identification numbers in brackets.

- This is all you have to do: Circle the corresponding numbers of any items that especially interest you on the postage-free tear-out card on this page. Then mail the card.

- Quickly the Reader's Service department will be working for you. All available information will be mailed at once to help you build a useful up-to-the-minute library from the technical booklets, pamphlets and pictures prepared for your use.

- Two Reader's Service cards are provided to allow two readers to make use of the service where copies of **Design Engineering** are passed on.

- There is, of course, no charge and no obligation.

HERE ARE 36 USES FOR

Closed Circuit

INDUSTRIAL TELEVISION

A new system of visual control for use in manufacturing plants, laboratories, hospitals, commercial establishments, training colleges — and wherever remote observation is desired.

INDUSTRY

Mixing processes whether in closed or open containers
Inaccessible moving mechanical parts
Time study of production or assembly line
Traffic flow at large loading platforms
Personnel movement for peak departmental operation
Staff training programmes
Central point observation of scattered process control instruments
Plant flow of materials
Process changes in materials
Personnel identification at plant entrances

COMMERCE

Property and personnel security
Staff training programmes
Dispatch and transport control
Pilferage control in stores and on wharves, etc.
Cheque signature verification for banks
Department stores sales demonstrations
Cooking schools
Traffic flow in exhibitions, public assemblies, etc.
Plant watching facilities at night
Visitor identification on restricted premises
Transmission of documentary information for central files

GOVERNMENT, PUBLIC AUTHORITIES AND INSTITUTIONS

Armed forces training programmes
Armed forces equipment
Personnel safety in munition plants
Forest-fire inspection
Submarine inspection of harbours, docks, wrecks, etc.
Scientific observation including microscopic or telescopic
Crowd and traffic control at public events
Hospital, clinical, medical and surgical demonstrations
Police line-up identification
Overflow audience at public events

EDUCATION

Child study
Vocational training
Examination supervision in practical subjects
Science demonstration — microscopic or telescopic
Group training and demonstration of techniques

We could easily list 136 and still not hit on the one application that makes sense in your operation

BUT YOU CAN!

INDUSTRIAL TELEVISION FOR REMOTE OBSERVATION

The potentialities of industrial television are almost unlimited — each day brings news of a fresh application in plants, laboratories, aircraft, ships and technical colleges.

Installation of "remote visual control" through Pye industrial television costs less than you imagine. Pye industrial cameras and screening apparatus are built for long life and efficiency with all the "know-how" the world-wide Pye organization has at its command.

WE INVITE YOU

to study the list of known applications. If none of them suggests a solution to your problem, we will be happy to work out adaptations with you. Just write us on your business letterhead.

PYE CANADA LIMITED, 60 Front St. W. TORONTO, Ontario.
or to: 1191 University St., Montreal, P.Q.
193 E. Hastings St., Vancouver, B.C.
83 Birmingham St., Halifax, N.S.

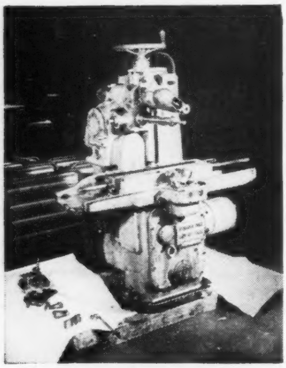
COMMUNICATIONS DIVISION

PYE CANADA LIMITED

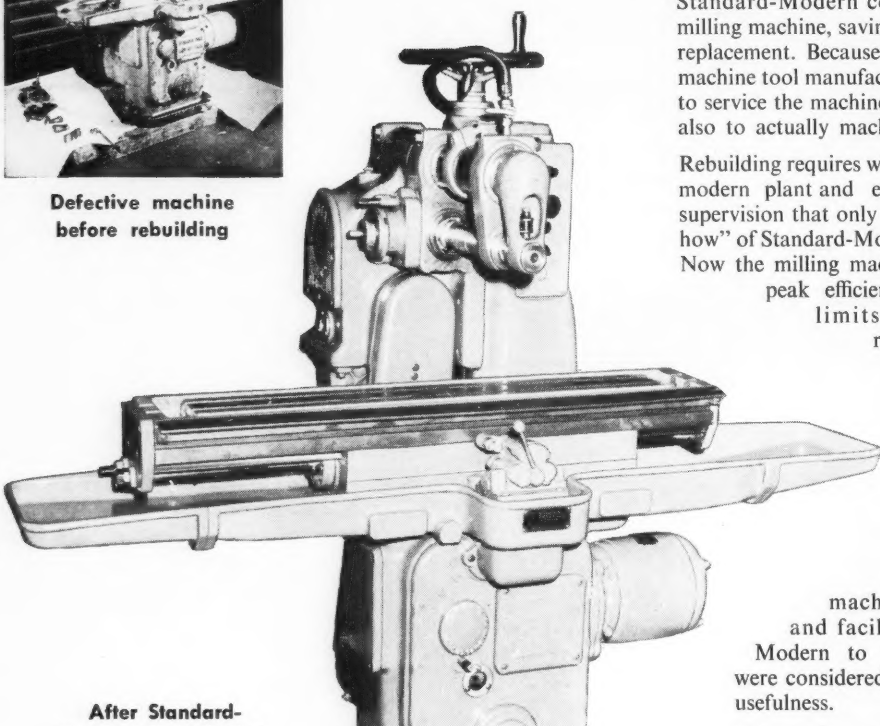
Engineers and consultants on mobile, fixed-to-mobile, point-to-point, and multi-channel radio communication systems; suppliers of telephone apparatus of all kinds; manufacturer and supplier of scientific instruments, industrial and commercial television cameras, radios, high-fidelity reproducers and television receivers.

How one manufacturer avoided a capital expense of $9,000

by rebuilding this machine tool



Defective machine before rebuilding



After Standard-Modern's rebuild job

Standard-Modern completely rebuilt this milling machine, saving its owners the cost of replacement. Because Standard-Modern is a machine tool manufacturer, it is not only able to service the machines in the usual way, but also to actually machine replacement parts.

Rebuilding requires wide experience, the most modern plant and equipment, and expert supervision that only a firm with the "know-how" of Standard-Modern is able to give you. Now the milling machine again operates at peak efficiency within Schlesinger limits, saving the cost of repairs in faster, more efficient operation.

Standard-Modern's experienced Sales Engineers offer you money-saving recommendations on rebuilding or replacing defective machine tools. Experience and facilities allow Standard-Modern to rebuild machines that were considered to have out-lived their usefulness.

If you have machines that are not working at peak efficiency, it costs you nothing to ask for advice from our well qualified Sales Engineers. Write, phone or wire any of our Sales Division's offices in the cities listed below.

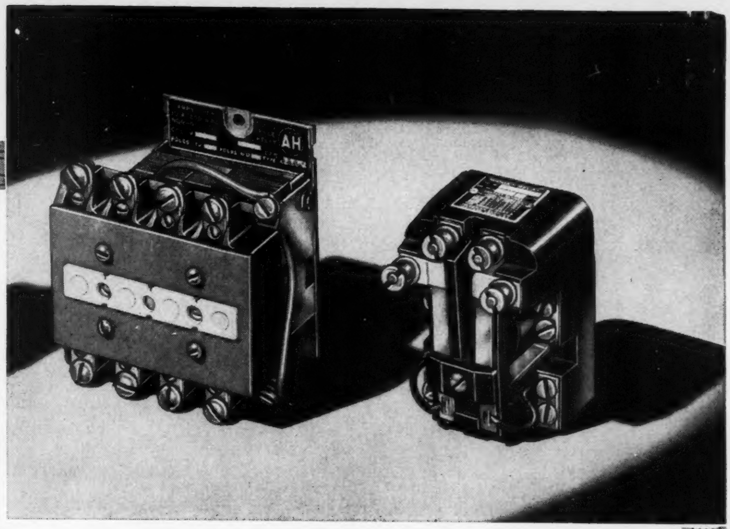
S M

STANDARD-MODERN TOOL CO. LTD.

TORONTO CANADA

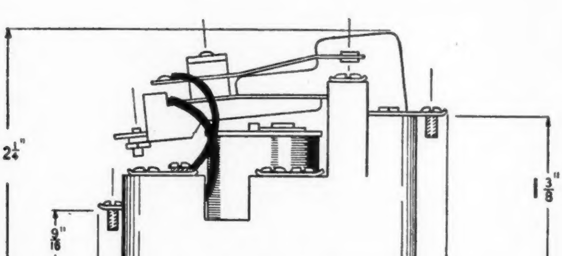
Sales Division: **The A. R. WILLIAMS MACHINERY COMPANY LIMITED**

Halifax, Montreal, Ottawa, Toronto, Windsor



need midget relays? —Specify ARROW AH HART

for long trouble-free service



This midget relay has a moulded base on which a large range of relays can be assembled from standard parts. Contacts are silver to silver butt type, amply proportioned and easily replaceable to give a contact rating up to 10 amperes at 240 volts A.C. Operating coils are of low wattage and continuously rated—less than 3 watts D.C. They can be supplied for various voltages from 6 to 550 volts A.C., and from 6 to 230 volts D.C.

Arrow Midget Relays are available for 1, 2, 3 or 4 pole circuit arrangements, in enclosed or open types. Write us for complete information today! There is a combination of Arrow Midget Relays to meet your specific needs.

INDUSTRIAL CONTROL DIVISION

C5402

ARROW AH HART

ARROW-HART & HEGEMAN

(CANADA) LIMITED

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Representatives: COCHRANE STEPHENSON (Western) Ltd., Winnipeg, Calgary, Edmonton
Vancouver: GEORGE C. ROBINSON, Saint John, N.B.

Patents

Some new ideas win protection in Canada

A PROCESS for joining a thin metal tube to a thick plate, invented by Otto Meyer of Luzern, Switzerland, was covered on April 26, 1955 by Canadian Patent No. 512,299, assigned to Metallschlauchfabrik A.G.

According to the patent, an outward flange is first formed at one end of the tube and the tube is placed on the work surface of a press, standing upright with the flange as its base. In the plate is a hole a little larger than the tube, and the wall of the hole is slightly hollowed out all around to give an annular concave surface. The hole in the plate is placed over the tube and the plate is slid down until it rests on the flange. A rubber disc about the same thickness as the plate is then laid on the working surface of the press inside the tube.

The press is then used to compress the rubber disc inside the tube, so as to expand its circumference against the wall of the tube and force it in turn against the wall of the hole in the plate. The pressure is sufficient to bulge the wall of the tube into the annular concave surface of the wall of the hole, and when the pressure is released the tube retains a bulge which secures it to the plate.

• • •

A DEFLECTION YOKE for a cathode ray tube is covered by Canadian Patent 514,-691 issued July 12, 1955 to Du Mont Television & Electronics, Ltd., of Montreal. It has a horizontal deflection coil of insulated copper wire, and a vertical deflection coil of insulated iron wire orientated to produce a magnetic field substantially at right angles to that produced by the first coil.

The inventor: Leon Seldin, of River Edge, New Jersey.

• • •

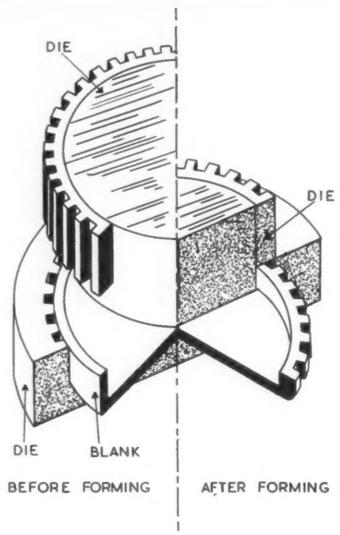
A NEW Patent No. 514,838 covers a process for modifying the surface of a metal article by the action of an impregnating or alloying metal.

The article is coated with an adherent mixture made by combining a source of the impregnating metal with slag-forming minerals and a liquid binding mixture. The minerals include silica, a source of silicon and a metal-halide fluxing agent.

The patent issued on July 19, 1955 to The Duriron Company, Inc., Dayton, Ohio; the inventor is Wallace C. Johnson of St. David's, Pennsylvania.

CANADIAN CARDWELL COMPANY, LTD., of Montreal, has patented a rapid low-cost process for making gears by forging the teeth on a disk. Invented by Jack Wilson of Chicago, the new method is covered by Canadian Patent 513,894 dated June 21, 1955.

As shown in the illustration, the gear is forged from a disk of wrought metal



with an upstanding circular flange or rim around its edge. The disk may be drawn or drop forged. Induction heating is used to heat it to forging temperature around the rim only, before it is put inside the cavity in the fixed die. Around the wall of the cavity is a ring of tooth cavities complementary to the teeth to be forged. A plug is put on the disk inside the rim and a forming die sleeved around the plug is brought down on top of the flanged rim, forcing the heated metal into the teeth cavity in the die.

According to the patent this simple method produces excellent gears.

• • •

A METHOD for making rubber-coated helical springs is the subject of Canadian Patent 514,882 issued July 19, 1955 to Latex Industries of London, England.

Invented by Lucian Landau of London, the method involves placing a partial coating on a metal spring in one mold, partially vulcanizing the rubber, and transferring the coated spring to a larger mold to complete the coating, which is then fully vulcanized.

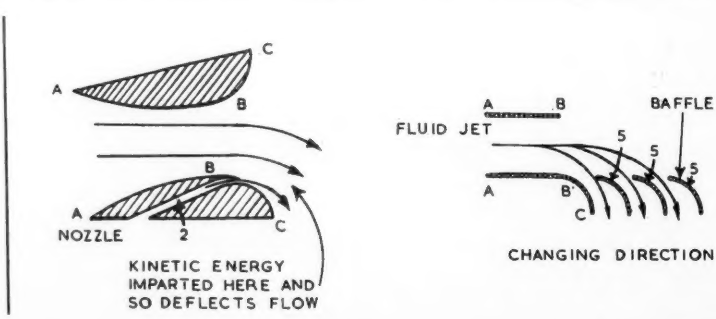
• • •

THIS ARRANGEMENT for deflecting a fluid jet was invented by four French inventors who have assigned their Canadian patent rights to Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, of Paris. Now protected by Patent No. 512,338 dated April 26, 1955, it can be used to deflect the jet from a jet propulsion unit in an aircraft to produce special thrust effects, such as a braking thrust to control the landing of an aircraft.

The invention covers the idea of arranging a curved wall beyond the outlet opening and outside the normal flow path of the jet. The jet is deflected toward the wall, which is convex on the side facing the flow, because of the natural tendency of the gas to adhere to the wall. To produce greater deflection, ducts or slots communicating with a region of lower pressure can be formed in the curved wall to reduce the pressure in the boundary layer of gas near the wall, as shown in the second illustration.

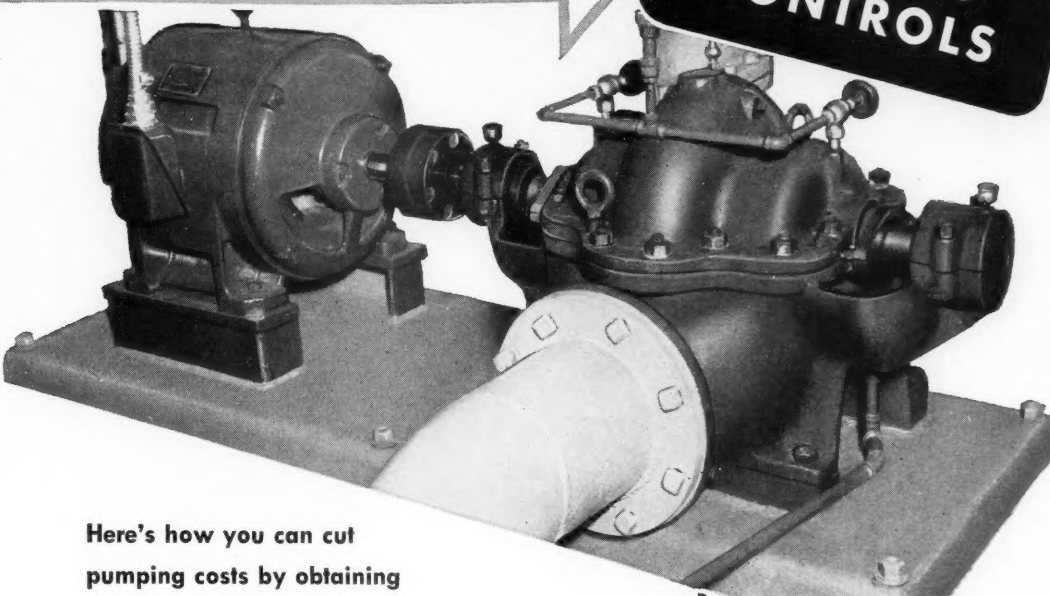
Another way to cause greater deflection is shown in the next illustration; the compressed gas is blown tangentially into the boundary layer to increase its kinetic energy.

The fourth illustration shows an arrangement of additional baffles or vanes outside the normal path of the undeflected jet, to produce greater deflection.



This "PACKAGE DEAL" can save you money

ALLIS-CHALMERS PUMPS MOTORS CONTROLS



Here's how you can cut pumping costs by obtaining your pump, motor and control as a complete unit!

1 You save on engineering time and costs because all components are co-ordinated, all parts match up properly, selection is faster, easier.

2 You save on installation costs because your pump and motor arrive as a complete unit, perfectly fitted, ready to go to work.

3 You save on service, because responsibility for performance rests with only one company — an important advantage.

4 You save in operation, because with all components engineered to a single set of standards, and designed to operate together, mechanical and electrical factors can be matched for maximum efficiency and economy.

MORE GALLONS AT LESS COST

Efficiency in the high 80's with reduced power consumption and lower maintenance—these are the principal factors that make this single stage, double suction pump so popular. Other advantages include:

Low cost replaceable parts protect casing and shaft at all points of wear . . . Ease of maintenance, with easy access to packing. Complete range of materials including bronze fitted, stainless steel, Ni-Resist, or special coatings . . . Wide range of sizes.

For complete information contact the CA-C Sales Office nearest you or write direct to Canadian Allis-Chalmers Limited, P.O. Box 37, Montreal, Que.

MADE IN CANADA

CANADIAN ALLIS-CHALMERS

A-C ALLIS-CHALMERS

55-CAL-2

ONE SOURCE

ONE RESPONSIBILITY

PUMPS

MOTORS

CONTROLS

Stress Lofting

(Continued from page 67)

of the accepted methods depending on the expression.

$$q = \frac{dP}{dx} = \frac{\Delta P}{\Delta x}$$

ultimately leads to a pattern of which figure 4 is typical. Each web will thus carry a shear load of q, which may be resolved into horizontal and vertical components ql cos $\propto$ and ql sin $\propto$ respectively. Then, as two further requirements of equilibrium,

$$\Sigma ql \cos \propto = 0 \quad \ldots\ldots\ldots \quad (4)$$
$$\Sigma ql \sin \propto = 0 \quad \ldots\ldots\ldots \quad (5)$$

Again, the shear in each web will have a moment about the structural axis of 2Aq. This provides a further requirement of:

$$\Sigma 2A.q = 0 \quad \ldots\ldots\ldots\ldots \quad (6)$$

In practice, it has been found that if requirements (1), (2) and (3) have been met and a sensible eye has been kept on web stiffnesses during the fairing process, requirements (4), (5) and (6) are unlikely to show that the pattern is seriously awry. As such, the philosophy has been to reconcile the surface so that only requirements (1), (2) and (3) are met, so providing a tentative pattern useful for assisting the designer and for preliminary stressing. Later, with more leisure, the pattern is examined in the light of requirements (4), (5) and (6).

The wing structure used as an example was actually examined in detail for five critical stressing cases; the root pickup loads were diffused to the "tentative" stage for all five cases in one week.

It cannot be claimed that such a basic approach can lead to a diffusion pattern which will withstand the most critical mathematical examination. On the contrary, it is merely claimed that a pattern derived so simply is useful during the project stage of design, providing, as it does, a pattern with which it is not easy to quarrel, since the basic requirements of consistent strain and equilibrium are demonstrated. The analogy of lofting is introduced to provide a literally graphic picture of the pattern, and to exercise the normal loft control over such a pattern during refinement cycles. Loft techniques, depending as they do on the purest curvature of all—that of a flexed spline—are likely to interpret the behavior of the physical material of a structure in a manner that is sensible. ★

Solar Symposium

PROMISES THAT MAN may soon draw on the sun as a source of energy for numerous applications in industry and home life appear evident.

With this inexhaustible force likely soon at his command, the World Symposium on Applied Solar Energy at Phoenix, Arizona November 1-5 comes as a timely union.

A grant of $26,500 by the Ford Foundation to the Stanford Research Institute is slated to aid more than 50 participating scientists and engineers from 30 countries.

As a prelude to the program, the delegates will attend meetings Ocober 31-November 2 at Arizona University.

Design Engineering, well aware of solar potential, has already carried information about the solar radio powered transmitter (April '55), and the solar battery (page 44 this issue). The solar furnace will be covered in October. ★

Advertising index — September

Editorial

Original Design Need Not be too Expensive

AWAY BACK IN 1929, the famous American designer and architect Mies van der Rohe, created a chair. It was described as a classic that would never change. How has the prediction fared during the 26 years that have passed since then?

It has fared very well. The Rohe chair is still in production; it is still selling throughout the North American continent; and it is still the same—precisely the same—chair that first came off the line.

Then, **Design Engineering's** readers are familiar with the telephone. They should be! Not only do they use it every day but it is exactly the same instrument they have had beside them for 18 years. Design changes that the Bell Telephone Company has just announced are worthwhile improvements sure of another long life without alteration.

One of Britain's faster sports cars now seen on the race tracks of the world is powered with an engine first produced in the twenties, skilfully modified.

And other examples of long life from good design are everywhere around us.

Yet Canadian industry moves steadily toward the American belief in quick obsolescence. This is a dangerous journey.

To American merchandisers there is magic in the twelve-month life. With the great wealth and numbers of U. S. consumers in mind, they may well be right to believe in it. But it is a different story in Canada.

Much of our industry believes it cannot afford the cost of developing its own products. Of course development is expensive; competent engineering staffs and tooling costs add up to a sizeable overhead to balance against sales.

Can a balance be struck? It can, if two things are done: Let industry forget the idea of quick obsolescence; and let it start now to speed the flow of exports. Here are two complementary moves to bring this country the big production it needs and so the chance to finance original products.

Good designers can study trends to predict the future. One (a Canadian engineer) has given **Design Engineering** an example: The era of the cooking range is coming to an end; the future will bring new on-the-spot cooking devices separately plugged in wherever they are handiest.

Here then is an opportunity for Canadian industry to move ahead; we could be designing our own point-of-use cookers, sure of a long production run ahead. And we could offer them to the world with the confident knowledge that if the trend is right and the product good, it will sell.

But industry can only lead like this if it frees itself of foreign dependence and restraint. Today, too many of our plants are controlled from abroad; too many of those that are free, fear to think for themselves.

Where are the men who will start a new journey toward the better, safer prosperity that comes from independence? Some, there certainly are, in management now. It is time they came forward.


Why
SHAKEPROOF® LOCK WASHERS
defeat vibration!
The purpose of lock washers is to keep screws and nuts tight.
Shakeproof Lock Washers provide positive locking action that ordinary washers cannot give.
Only Shakeproof Lock Washers have these exclusive tapered-twisted teeth . . .
where each tooth is a strut to resist all loosening rotation of threaded fastening.
Spring tension forces the edges of each tooth to bite deeper.
Shakeproof Lock Washers lock tighter as vibration increases . . .
and the locking power of each tooth is multiplied by the number of teeth.
Their exclusive mechanical lock resists loosening as no other lock washer can!
To meet the majority of your locking needs, there are nine standard types.
The variety and styles of "specials" to meet individual requirements are unlimited!
For maximum savings, buy Shakeproof Lock Washers pre-assembled on screws as SEMS.
Pre-assembled on nuts, Shakeproof Lock Washers save time—specify KEPS®.
Free Sample Kit
Shakeproof LOCK WASHERS
. . . make your own tests! See for yourself how SHAKEPROOF
ck Washers can save time in assembly and protect the quality
of your products. Write for your free sample kit today!
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177 FRONT STREET E, TORONTO 2, CANADA
RLD'S BROADEST LINE OF
-ASSEMBLY FASTENINGS

How TIMKEN bearings maintain spindle precision, accurate gear mesh on extra heavy-duty lathe

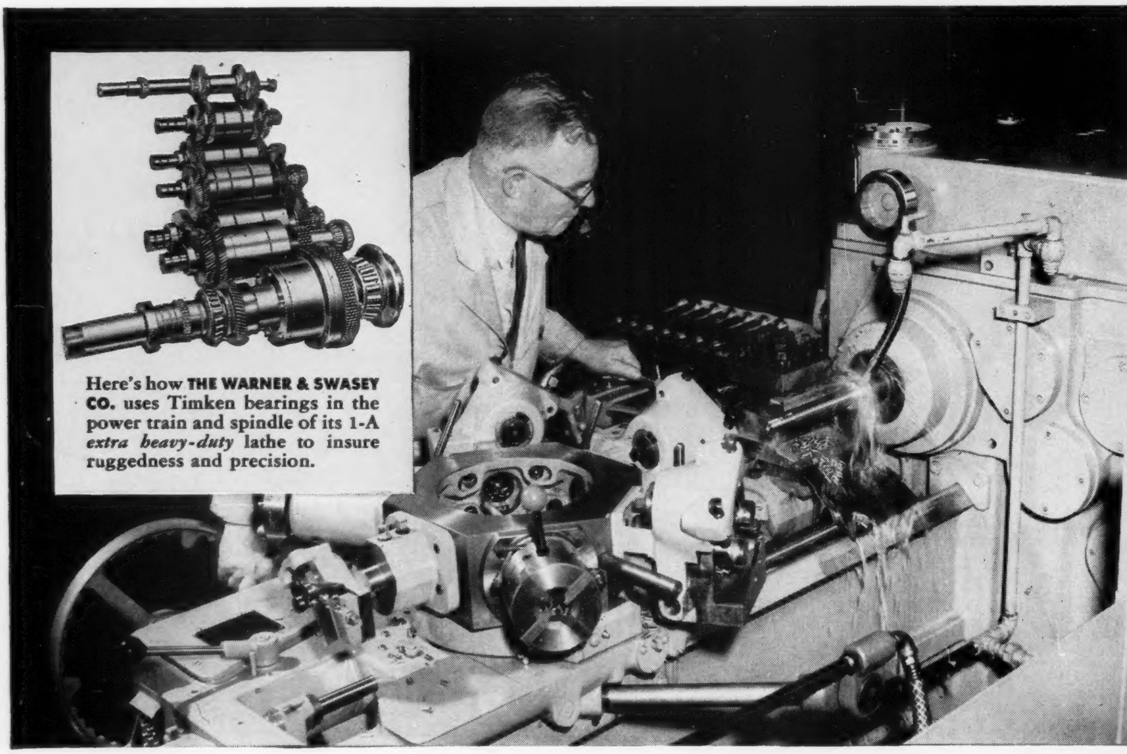
AT the flick of a lever, the operator of this Warner & Swasey 1-A *extra heavy-duty* lathe can get any one of 16 spindle speeds immediately. Then, with the right speed for the job, this lathe can hog off a lot of metal fast—and still turn out close-tolerance parts.

To help assure both precision and ruggedness, at any speed, Warner & Swasey engineers have mounted the spindle and gear train on Timken tapered roller bearings. Timken bearings maintain spindle precision and accurate gear mesh day in and day out, piece after piece. They're tapered to take both radial and thrust loads, in any combination. Full line contact between rollers and races provides maximum capacity. Shafts are held in alignment. Gear mesh is smoother, more accurate. Shaft wear is eliminated, gear wear reduced.

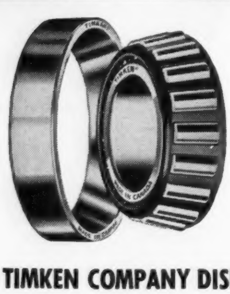
True rolling motion, plus almost microscopically smooth surfaces combine to make Timken bearings practically friction-free. They're made from Timken fine alloy steel—steel that's nickel-rich for extra toughness. Rollers and races of Timken bearings are case-hardened for hard, wear-resistant surfaces and tough, shock-resistant cores.

No other bearings can offer you all the advantages of Timken bearings. That's why so many manufacturers of fine equipment use them. Whether you build or buy machinery, be sure to specify Timken bearings. And look for the trademark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. **CANADIAN PLANT:** St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Here's how **THE WARNER & SWASEY CO.** uses Timken bearings in the power train and spindle of its 1-A *extra heavy-duty* lathe to insure ruggedness and precision.



TIMKEN *Made in* **CANADA**

TRADE-MARK REG. IN CANADA AND U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

FOR CANADIAN INDUSTRY

See the TIMKEN COMPANY DISPLAY at the PRODUCTION ENGINEERING SHOW, Navy Pier, Chicago Booths 425-426 Sept. 6 thru 16

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION